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CUSHMAN CE-80B

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CE-80B Automatic PCM Fault Locating Test Set

MAINTENANCE MANUAL

Cushman

CE-80B
Automatic PCM
Fault Locating Test Set

MAINTENANCE MANUAL

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UNPACKING AND INSPECTION

When unpacking the Model CE-80A/CE-80B, inspect the packing box and the instrument for possible damage. The instrument was carefully inspected before shipment and should be ready to operate properly when received. Confirm satisfactory performance by following the procedures given in the Operating Section of the Instruction Manual. If the equipment is damaged or fails to operate properly, file a claim with the transportation agency, or if insured separately, with the insurance company.

SECTION 1
GENERAL

INTRODUCTION

1.01 The Cushman CE-80A/CE-80B Automatic PCM Fault Locating Test Set is a T-Carrier test instrument for automatically locating failures in PCM span lines. The CE-80 can test T1, T1C, T148C (optionally T148), and Duobinary systems. It can also automatically perform all standard noise threshold, Measure 1, Measure 2, Measure 3, and obscure trouble (Pulse Period) tests on a repeater in ten seconds. The returned fault line absolute signal level is displayed (in dBm) on the CE-80 digital readout, while the relative difference (in dB) between the returned level and expected level is displayed on an additional analog meter. If signal levels exceed CE-80 preset limits for absolute and relative levels, the testing will automatically stop at the failed test, and a FAIL indicator will light. Testing can also be performed manually for all tests in the sequence.

1.02 The CE-80 also has a PCM generator which provides the standard QRSS word pattern, and can modify the pattern to provide bipolar violations and logic errors. There is also an "ALL 1's" pattern for additional testing flexibility.

1.03 The CE-80 also provides in-service error monitoring of active span lines by the PCM Detector function, which checks for bipolar violations, pulses, all ones, and oscillations on the line.

ACCESSORIES AND OPTIONS

1.04 Each CE-80 is shipped with an Operational and a Maintenance Manual. Accessories which are also available for the unit include a shipping trunk (CE # 5287-0056), a soft carrying case (CE # 5287-0055), 44 pin (CE # 7001-0568) and a 72 pin (CE # 7001-0569), extender boards, a 19" Rack Mounting Kit (CE # 7101-0106), and a 23" Rack Mounting Kit (CE # 7101-0107).

1.05 Options available include the M1 Option to replace the standard ITT T148 system test capability in the CE-80A with the ITT T148C, and the M2 Option to replace the 110V AC input power circuitry to allow 230V AC input power to be used. Additional options for the CE-80B include Option M3, which allows testing of active fault lines, and Option M4, which replaces the Standard CE-80B ITT T148C test capability with ITT T148.

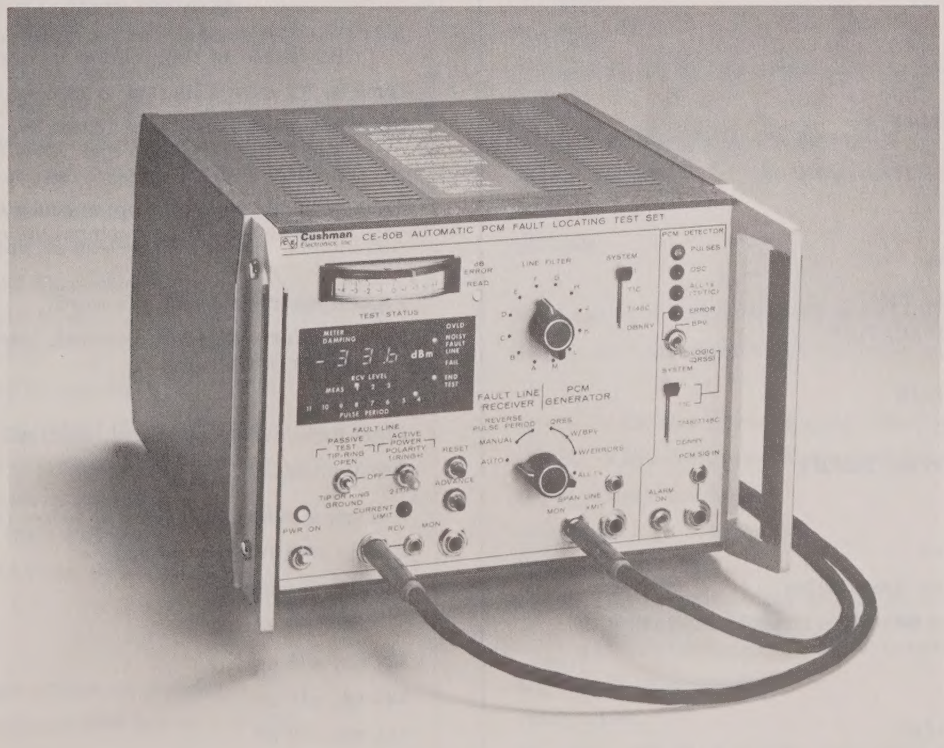


Figure 1-1. CE-80A/CE-80B Automatic PCM Fault Locating Test Set

SPECIFICATIONS

1.06 Specifications for the CE-80A/CE-80B are listed in Table 1-1.

TABLE 1-1

CE-80A/CE-80B SPECIFICATIONS

ITEM	SPECIFICATION
Pulse Generator	
System Clock Frequencies	
T1	1.544 MHz ±100 PPM
T1C, DBNRY	3.152 MHz ±30 PPM
T148C (in place of T148)	2.364 MHz ±60 PPM
T148 (in place of T148C)	2.370 MHz ±60 PPM
Pulse Patterns	
MEAS 1	Trio/Trio pattern with one bipolar violation in each group. Polarity alternates at an audio rate.
MEAS 2	Trio/Doublet pattern with one bipolar violation in each trio group. Alternates at an audio rate.
MEAS 3	Same as MEAS 2 except pattern polarities are reversed.
Pulse Periods	11 to 4 automatically or manually controlled.
QRSS	
T1	A 1,048,575 bit quasi-random word (QRW) sequence limited to 14 consecutive zeroes.
T1C	Same as T1 except limited to 19 consecutive zeroes.
T148C/T148	Same sequence as T1; bits 12 and 20, and inverted bits 6 and 7 encoded into T148/T148C compatible output.
DBNRY	Same sequence as T1 except encoded into a GTE Modified Duobinary compatible output.
With BPV	
T1, T1C	Eight bipolar violations per word.
T148C/T148	Eight bipolar violations, nominal, per T1 sequence prior to encoding.
With Errors	
T1, T1C	Eight logic errors per word, nominal.
T148C/T148, DBNRY	Not applicable
ALL Ones	A mark of alternating polarity every time slot.
Pulse Amplitude	3 volts ±0.15V base-to-peak
Pulse Amplitude Asymmetry	±0.15V, maximum
Pulse Width (at 50% base-to-peak amplitude)	
T1	324 ns, ±30 ns
T1C	160 ns, ±15 ns
T148/T148C	211 ns, ±20 ns
DBNRY	317 ns, ±30 ns
Pulse Width Asymmetry	15 ns maximum

Table 1-1. CE-80A/CE-80B Specifications (cont'd.)

ITEM	SPECIFICATION
Pulse Afterkick Amplitude	
T1	10% - 30% of pulse amplitude
T1C, DBNRY	10% of pulse amplitude (maximum)
T148C/T148	20% - 40% of pulse amplitude
Pulse Rise and Fall Times	30 ns maximum
Audio Modulation Frequencies	A 832 E 1340 J 2193 B 928 F 1508 K 2413 C 1048 G 1722 L 2680 D 1206 H 2008 M 3017
Audio Modulation Frequency Accuracy	±2%
Termination Impedance for Specified Output	100Ω, ±1%
Fault Line Receiver	
Input Impedance over Audio Frequency Input Range	900Ω, ±10%
Input Range (Autoranging) at 900Ω	- 90 dBm to 0 dBm
Maximum Digital Readout	
MEAS 1, Pulse Period 4	0 dBm
MEAS 1, Pulse Period 11	-12 dBm
MEAS 2 or MEAS 3, Pulse Period 11	-16 dBm
Effective Filter Bandwidth	-3 dB at F_o ±5 Hz, maximum; ±2 Hz, typical
Overall Level Accuracy	±1 dBm
Meter Damping S/N Threshold	±5 dB over Line Filters A through M
Noisy Fault Line Threshold	+14 dBrnC minimum; +16 dBrnC maximum
Analog Meter Reading Accuracy	±0.2 dB
Digital Readout Resolution	±0.1 dB
FAIL Limit Threshold	
MEAS 2 and 3	±1.5 (±0.2) dB about MEAS 1 reference sample
MEAS 3	±1 dB, ±0.2 dB about MEAS 2 reference sample
END TEST Threshold	
Pulse Period Mode, Manual	+2 dB, -1 dB about preceding reference sample
Pulse Period Mode, Reverse	+1 dB, -2 dB about preceding reference sample
Low Frequency Rejection	80 dB minimum at 60 Hz
Common Mode Rejection	60 dB minimum below 4 kHz
Auto Cycle Time (S/N > 5 dB)	10 seconds typical
PCM Detector	Four LEDs indicate status for PULSES, oscillations (OSC), and BPVs for all systems, and ALL 1's and LOGIC errors for T1/T1C systems.
Input Range (Pulse Amplitude)	0.2V to 4V base-to-peak
Input Impedance (700 kHz to 1.6 MHz)	105Ω, ±10%
System	T1, T1C, ITT T148/T148C, and GTE Lenkurt Modified Duobinary
Alarm Tone	Selectable tone alarm to indicate BPV or logic errors, or no pulse conditions.

Table 1-1. CE-80A/CE-80B Specifications (cont'd)

ITEM	SPECIFICATION
PCM Detector (cont'd)	
BPV Output	BNC on rear panel for counter or recorder
Display Time	40 msec. for each occurrence
Input Connector	WECO 310 and miniature jacks
Fault Line Test	Two position switch tests fault line for TIP-RING open and for TIP OR RING GROUND. FAIL and END TEST status LEDs display test results.
TIP-RING Open Threshold	> 10 kΩ, ±15%
TIP OR RING GROUND Threshold	< 200 kΩ, ±10%
Noise Threshold	Noise on fault line is tested automatically to preset threshold of +14 dBrnC. If level is exceeded, the NOISY FAULT LINE LED on the test status display lights.
Active Fault Line Power Supply (Option M3)	
Output Voltage	+118V DC
Overall Tolerance (No load to full rated load over temperature)	±3V DC
Rated Output Current	12 mA
Current Limit	15 mA
Safety Interlock	High voltage output is available only when sleeve terminal of FAULT LINE RCV is grounded.
Power Requirements	115V AC, ±10%, 50-60 Hz, 20W nominal (230V AC optional)
Dimensions	7.5" H x 10.6" W x 13" D
Environmental Requirements	
Temperature	
Ambient, Operating	0° C to +55° C
Storage, Non-operating	-40° C to +75° C
Humidity	90% RH, +40°C
Vibration	10-55 Hz, 0.01" P-P amplitude excursion
Shock	4" bench drop
Altitude	
Operating	15,000 ft.
Non-operating	25,000 ft.

SECTION 2
THEORY OF OPERATION

INTRODUCTION

2.01 The Theory of Operation section is divided into four subsections. The first is a description of the Circuit Reference Series which is used for circuit and component identification. The second is a general overview of the instrument operation. The third describes the overall functioning of the instrument from a block diagram viewpoint. The fourth is a description of the operation of the circuits as mounted on the circuit boards.

CIRCUIT REFERENCE SERIES

2.02 The Circuit Reference Series is a series of numbers assigned to the circuits of the instrument to make it possible to relate the actual circuit board or assembly to the schematic diagrams, the parts list and the text of the manual with a minimum of effort.

2.03 The series numbers assigned to the CE-80 are as follows:

1000	Front Panel
2000	Main Chassis
3000	Rear Panel

Figure 3-1 shows the CE-80 circuit board locations.

2.04 Under each main grouping the circuits are further divided into 100 number groups (e.g., 2100, 2200, etc.), each of which represent circuit boards. On each circuit board the components are individually numbered in a series starting with 1, each type of component having a separate series as designated by a letter or letters. The complete reference to any component includes the circuit reference number, the individual component number and the letter type indicator. For example, the first resistor, R1, in the 2100 board circuits will be R2101, the second transistor, Q2, will be Q2102, and so on. The printed circuit board plugs and connectors are similarly designated with pin numbers following the component reference as a dashed number. For example, the first plug for the 2100 circuit board would be P2101, and pin 4 of that plug P2101-4.

2.05 When the individual circuits are described in the Circuit Description the component references will be abbreviated for convenience. Thus, R1 will refer to the first resistor on the board under consideration only. If reference is made to a component outside that board or when more than one circuit is being described, the full reference designation will be used.

2.06 In order to identify each board a cross reference table is given at the beginning of Section 4 listing the basic board numbers in sequence. These numbers are etched on each board. Also listed are the board title, assembly number, circuit reference number and the figure and page number of the schematic diagram. The basic board number is the 1780-xxxx series. In cases where the board is too small for the complete number, only the last four digits are used. The basic number, along with the assembly number and the circuit reference number, also appears in the parts list for each board.

General Overview

2.07 The CE-80A/CE-80B Automatic PCM Fault Locating Test Set is used to monitor a carrier span line operation, or to locate the failed component of a malfunctioning carrier span line.

2.08 Carrier span line monitoring is done by the Error Detector section. The signal input at the PCM SIG IN connector is checked for errors, oscillations, bipolar violations, and/or an all one's condition. If any of these problems are detected, the appropriate Error Detect lamp will be turned on, and an audible alarm (if selected) will alert the operator. To locate a failed repeater or line section in a carrier span line, the CE-80A/CE-80B Automatic PCM Fault Locating Test Set is connected to the fault location (such as a Central Office). Each repeater on the span is associated with a narrow bandpass audio filter on the fault line. The CE-80A/B generates a series of test signals of known level and content over the fault line at an audio frequency which will be accepted by the filter of the repeater to be tested. This signal will go to the tested repeater over the fault locating line, be refreshed by the repeater, and returned to the CE-80A/B receiver. The returned signals are then compared in the CE-80A/B to those transmitted. If the returned signals exceed limits set in the CE-80 A/CE-80B, appropriate LED's and meter levels alert the operator to a possible failure in the section under test.

Functional Description

2.09 There are three functional sections to the CE-80A/CE-80B Automatic PCM Fault Locating Test Set. The Error Detector section is made up of the Error Detector (2400) PC board and associated switching, controls, indicators, and interconnects. The Transmit section includes the Clock Osc/QRSS (2600), Pattern Generator/Pulse Driver (2500), Sequence Logic (2300), and LPF/Audio Gen (1200) PC boards and associated circuitry and controls. The Receive section contains the Synchronous Detector (2200), Receiver/Converter (2100), and Display (1100) boards with their controls and interconnects.

Error Detector

2.10 To monitor a T1, T1C, T148 (or T148C), or Duobinary carrier span line, the span line signal is connected to the CE-80A/CE-80B PCM

SIG IN connector. When the PCM Detector System switch is set to the correct system to be tested, the signal is checked on the Error Detector (2400) PC board to determine if there are errors, bipolar violations (BPV's), oscillations, and/or an all 1's condition. If a problem is detected, the Error Detector board will cause the appropriate lamp and audible alarm (if selected) to be turned on.

Transmitter

2.11 The test signals transmitted by the CE-80A/B start with the clock oscillators on the Clock Osc/QRSS (2600) board. The selected oscillator output is sent to the Pattern Generator/Pulse Driver (2500) board clock count down circuits where the correct clock rate for the signals is derived. This clock rate is returned to the Clock Osc/QRSS (2600) board 20 bit shift register where the standard PCM quasi-random word is generated. This (QRSS data) word is returned to the Pattern Generator board pattern generator circuits. Here, inputs from the Sequence Logic (2300) board determine which of the automatic CE-80A/B tests is to be performed, and the pattern generator logic develops the necessary signals, or test pattern.

2.12 Added to this test pattern is audio information generated on the LPF/Audio Generator (1200) board. This audio frequency is determined by the setting of the CE-80A/B LINE FILTER switch, and is four times the needed frequency. It is divided down on the Pattern Generator board to the correct audio frequency, and used to gate out the selected test pattern (at that audio rate) to the bipolar pulse driver circuits.

2.13 The bipolar pulse drivers transmit the generated test pattern information in bipolar form through the CE-80A/B SPAN LINE XMIT output to the span line repeater selected for testing.

Receiver

2.14 Fault line signals are received by the CE-80A/B at the FAULT LINE RCV input and sent to the Receiver/Converter (2100) board. The signals are first checked for noise level, and if it is above a set threshold, the NOISY FAULT LINE LED will light.

2.15 The received signal level is displayed on the Display (1100) board digital readout. Ranging logic amplifies the received signal up to 90 dB, and on the Synchronous Detector (2200) board the level is compensated further for level differences due to the type of test in progress. The signal is then returned to the Receiver/Converter board where it is compared to a reference level. This comparison causes auto-range circuitry on the Receiver/Converter board to add or reduce amplification of the received signal (up to 90 dB) until the received amplified signal falls within a required level window. The Synchronous Detector board, besides compensating the level for differences in the type of test, also compares the received level to an expected level for that test and displays the level difference on the dB ERROR meter. For example, assume that the last test performed was the MEAS 1, Pulse Period 11 test, and the CE-80A/B is now making a MEAS 2 test. The Synchronous Detector board circuits will add the expected 6dB difference in level between these two signal types and compare the compensated signal levels. Since any difference in level could only be caused by the span line, it is displayed on the dB ERROR meter as a measure of the span line's capability for that test.

CIRCUIT DESCRIPTION

2.16 A circuit description of the CE-80 boards follows the outline set by the Functional Description of the unit operation. The Error Detector board is discussed first, followed by descriptions of circuit operation of the Transmitter section and then the Receiver section boards.

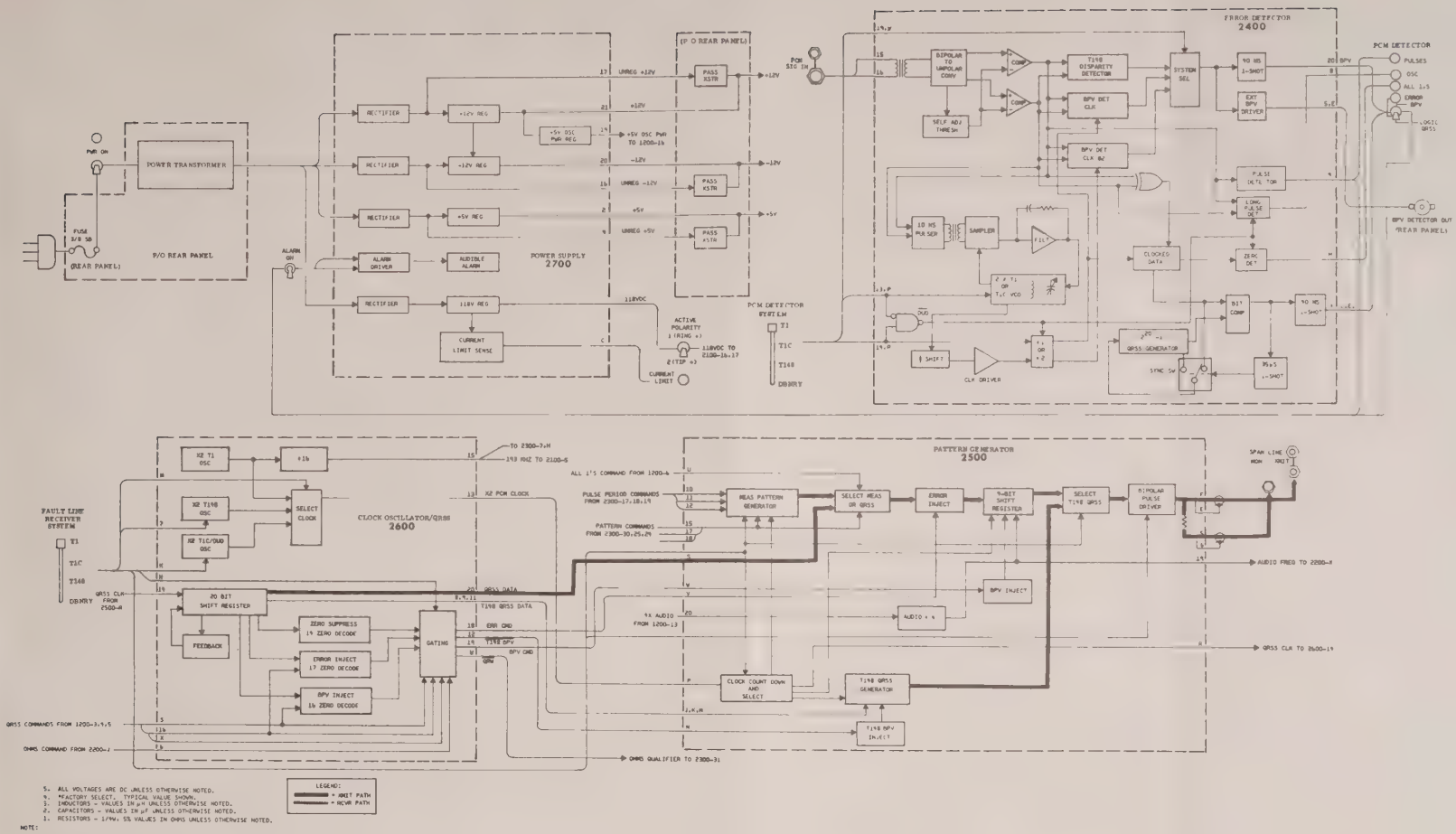
Error Detector, 2400

2.17 The purpose of the Error Detector board is to check the input Pulse Code Modulated (PCM) bipolar signal for bipolar violations, logic errors, T148 disparities, and oscillations or all ones on the input line. If any of these conditions exist, the PCM input signal is in error, and a front panel LED is lighted to alert the operator to the type of error found.

2.18 The PCM SIG IN comes onto the Error Detector PC board at P1, pins 15, 16 as a positive and negative going (bipolar) signal. The signal is transferred across T1 to U31 where the bipolar input is converted to two unipolar, positive pulse signals to ground for ease in processing. The U31 pin 7 output is one pulse for each positive-going pulse of the bipolar input, and pin 10 is one pulse for each negative going bipolar input pulse. The two U31 outputs go to U23 dual drivers, where the pulses are squared and sent simultaneously to the Disparity Detector, Violation Detector, OSC or ALL I's Detector, and the Clock Gen. circuits.

2.19 At the Disparity Detector circuits, the pulses from U23 are compared by causing U23 pin 4 output to count up, and U23, pin 9 to count down, the 4-bit binary UP-Down counter U19. If there are no T148 disparities, the up and down counts of U19 will be equal and there will be no input to Disparity Detect gate, U26. If more than four T148 disparities are detected, then the U19 inputs to U-26, pin 4, 5 will cause the Detect gate output to U25, pin 1 to be enabled. Then if the PCM Detector SYSTEM switch is in the T148 position, NAND gate output U25, pin 3 is enabled, causing U32 to be set.

2.20 The U23 (A) and (B) outputs are also compared by dual flip-flops U16 and U17 in the Violation Detector circuits. The first U16, U17 pair will enable U18, pin 2 if TI or TIC system bipolar violations (BPV's) are detected. The second U16, U17 pair enables U18, pin 1 for the alternate clock phase of the GTE modified Duobinary system BPV's. Clocking for the first flip-flop pair comes from U3, pin 12 output. With no bipolar violations, the U23 (A) and (B) outputs alternately set and reset. If



NOTE:
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.

Figure 2-1. CE-80A/CE-80B Block Diagram, Sht. 1 of 2

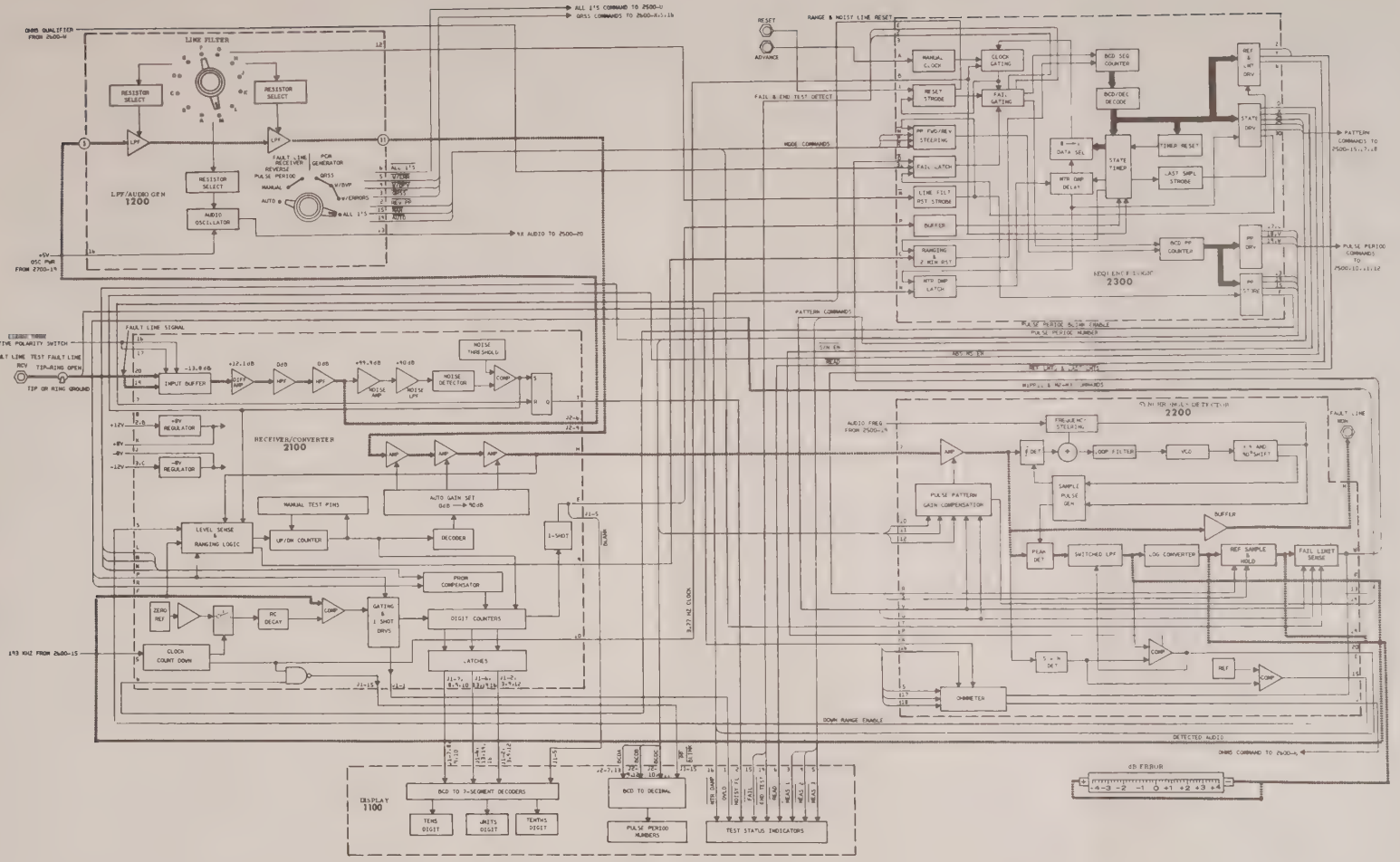


Figure 2-1. CE-80A/CE-80B Block Diagram, Sht. 2 of 2

there is a bipolar violation, however, either U23 output (A) or (B) will give 2 consecutive pulses to the U16 set or reset input. This means that while U16 is already set (or reset) it receives a second setting (or (or resetting) pulse. The NAND gate U10 pin 11 (or pin 3) will be enabled, setting flip-flop U17. This will enable the NAND gate input, U25 pin 9.

2.21 If the input signal from PCM SIG IN is from a GTE Modified Duobinary system, the U23 (A) and (B) output pulses will be applied to the set and reset inputs of both U16 flip-flops. Since the U16 pin 5 clock input is LOW while the first U16 pin 1 clock is HIGH, and vice versa, the two U16 flip-flops can monitor the state of the input Modified Duobinary signal at alternate clock phases. If there is a BPV in the signal, it will appear as a bipolar violation in one of the alternately clocked data channels of U23. This will cause one of the U16 flip-flops to remain in a set or reset state while the next pulse is input, enabling NAND gate U10 and setting either the first or second U17 flip-flop. The U18 pin 6 output will be LOW and cause U25 pin 8 output to set U32 pin 6. This turns ON switch Q2 and lights the BPV lamp.

2.22 Pulses at the output of U23 also trigger the 2.4 millisecond one-shot multivibrator U21. The U21 pin 13 output is buffered through U35 to the PULSE output at connector P1 pin 9. This signal also enables gate U24 pin 5 input. Pin 4 of U24 will be enabled (HIGH) if U29 is reset, meaning oscillations were detected. In the CE-80B, the LOW output of U24 pin 6 is then output through U30 pin 6 and LED driver U35 Pin 6 to connector P1 pin 8, lighting the OSC LED. In the CE-80A, the U24 pin 6 LOW output is inverted through buffer U35 pin 10 and triggers Timer U34 (in the circuit as an astable multivibrator). When triggered, the U34 Timer will oscillate at a 3 Hz rate and flash the OSC OR ALL 1's LED on the CE-80A front panel. The Timer operation is normally inhibited by the LOW pin 10 output of U35 except when line oscillations are detected (U29 pin 12 LOW)

2.23 The U34 Timer oscillations can be inhibited also by a LOW Reset input from U30 pin 8. This can occur when all inputs to the U30 gate are HIGH. Normally, the Zero Detect (U6 pin 12) output will be LOW, and will only go HIGH if no zeroes are detected (the input is all 1's). When this occurs, U30 pin 8 goes LOW (holding the Timer in a reset condition) and the LOW is carried through U35 LED Drivers to connector P1 pin H, turning ON the OSC OR ALL 1's LED.

2.24 In order to synchronize the receiver error detect circuits with the incoming PCM SIG IN data, the U23 unipolar output pulses are used to generate a clock frequency for receiver operation. The unipolar pulses are input to U22, pin 2,4,9 & 12. The output of U22 is one pulse of 10 nanosecond duration applied to T2 for each input pulse. At diodes CR2-5 the pulses are detected, turning on the diodes for the duration of the pulse. At the junction of CR2 and CR4, the output frequency of the clock recovery VCO Q4,Q5, and Q6 is sampled, and the voltage difference, averaged by C25, applied to pin 3 of U15. Filter U15 removes unwanted frequency components from the voltage and applies it to CR12 varicap, where it adjusts the Clock Recovery VCO to the correct frequency of 2 times the T1 frequency, or T1C rate. The VCO output is taken from Q4 collector, phase shifted as required, and applied to U1 clock driver for shaping, after which it is input to U3 (for T1 divide by 2) and U12, pin 2 (for T1C clocking). The output of NOR gate U12, pin 4 is now the clock signal for the input data error measurement process.

2.25 The error detector board contains a Quasi-Random Sequence Source (QRSS) generator consisting of U20 and U27 shift registers and U33, U36 flip-flops. This QRSS generator operates like the one on the Clock Osc/QRSS (2600) board, except it can be synchronized to incoming data. Unipolar input data from U23 (A) and (B) is input to flip-flop U4, pin 12, through exclusive OR gate, U5, pin 11. The U4, pin 9 output goes to two different gates; NAND gate U7, pin 1 and Exclusive OR gate U5, pin 1. The NAND gate output, U7, pin 3, cannot be enabled except by the 35 microsecond "ON" time of 1- shot U6, pin 13, the data synchronizer. If not synchronized, the bit-by-bit comparison of the QRSS generator output at U5, pin 2, and the input data at U5 pin 1 will cause U5 pin 3 output to go true, setting flip-flop U4, pin 5 output. One-shot U6, pin 13 will now be set, and enable U7, pin 3 output. This allows the input data present at U7, pin 1 to be loaded into the QRSS generator, synchronizing the generator sequence to that of the incoming data. Being now synchronized, the data comparison of U5, pin 1 and 2 hold its output low, and disables the setting of flip-flop U4, pin 5. With U4 reset, flip-flop U32 pin 10 will reset, disabling switch Q9, and shutting off the logic ERRORS Lamp.

Clock Oscillator/QRSS, 2600

2.26 The purpose of the Clock Osc./QRSS board is to generate the frequencies needed for clocking and transfer of quasi-random data, and to develop the standard quasi-random data word (QRW) used in testing PCM fault lines.

2.27 Common base oscillators Q1, Q4 and Q6 are crystal controlled feedback oscillators operating at a frequency two times the desired system frequency. This frequency is required to produce some portions of the synthesized test patterns.

2.28 Oscillator Q1 is not selectable, but always on. The oscillator's sinewave output is buffered by Q2, and applied to switch Q3, which changes the sinewave output to a TTL compatible square wave to be applied to the divide-by-16, U13, and to U9, pin 5 of the clock select circuits. The output of U13 is a precision 193 KHz data synchronizing clock used in the CE-80 Sequence Logic and Receiver/Converter circuits.

2.29 Oscillators Q4 and Q6 are turned on by the position of the PCM Generator SYSTEM switch. Q4 oscillates in the T148 position, and Q6 in the TIC or DBNRY position. The oscillator outputs are buffered by Q5 and Q7, respectively and squared by Q8 to be applied to U9, pin 12. The U9, pin 8 output selects one of the three oscillator outputs to send to the Pattern Generator clock count-down and select circuits.

2.30 Shift registers U11, 14 and 16, with feedback gating from U5A, U6A, U7A-B, and U15A-B provide a

quasi-random signal source (QRSS). The shift registers are set up as a single 20 bit serial input, serial/parallel output register. The frequency at which the U14, pin 1,2 input is clocked into the register by P1-14, QRSS Clk is determined by the type of system (TI, TIC, etc...) to be tested. The register input from U15A, pin 3 comes from 2 sources. Nor gate output U7B, pin 4 will be high if bit positions 1-19 of the register all contain zeroes. This will cause a bit to be inserted into the register to prevent an all zero latch-up, which might occur at unit turn-on. With the quasi-random signal source operating, bits are shifted through the register from bit position one to position 20 at the QRSS Clk rate. The exclusive OR gate U15B, pin 8 output will go high if there is a bit detected at positions 17 or 20 (QRSS Data output), but not both simultaneously, and insert a bit into the register. The output of U15B, pin 8 determines the quasi-random insertion of data into the register, and will cause a continuously repeating data sequence to be entered. This data sequence, called a quasi-random word, repeats after each 2^{20}-1 bit times (1,048,575 possible bit combinations, except for all zeroes, which the register can have). It is output from U16, pin 6 (register bit position 20) to P1-20 to be sent to the Pattern Generator (2500) circuits as QRSS DATA.

2.31 Decoding logic consisting of gates U10 A,B, C, U12 A,B, and U15C monitor the parallel outputs of the QRSS register as the contents are shifted a bit position at a time from position 1 to 20. Certain bit patterns in the QRSS register are detected by other decoding gates and used to generate the signal patterns generated by the CE-80A for PCM fault-line testing.

2.32 The output of NAND gate U6B, pin 6 will go low if the register contents contain zeroes in bit positions 6-19. This 14 zero detect sets dual flip-flop U8A as the next clock pulse shifts the register contents 1 bit, so zeroes are in positions 7-20, and one bit later sets U8B. The 14 zero detect latch (U8A,B) outputs are applied to NAND gates U5C,D which, if the CE-80A is set to test TI or Duobinary systems, will enable the ERR CMD output of U4B, pin 8 to P1-18. This ERR CMD signal causes other circuits to alter the QRSS DATA word so that no more than 14 consecutive zeroes can be output, and logic errors are inserted in the output data word.

2.33 The output of NOR gate U2A, pin 1, will set flip-flop U3A if both inputs are low, signifying zeroes in register positions 3-19. This 17 zero detect latch output is applied to NAND gate U5B, pin 9. If the FAULT LINE RECEIVER/PCM GENERATOR switch is in the W/BPV position at this time, U5B, pin 8 will go low, and the output at P1-12 will be enabled for inserting T148 disparities in the output.

2.34 The 16 zero detect NAND gate, U4A, pin 6 output is low if there are zeroes in register bit positions 1,2,6-19, and the CE-80A is set to generate bipolar violations (BPVs). This enables the P1-19 BPV CMD signal to allow the insertion of BPVs in the output data word.

2.35 The output of U7D, pin 1 to P1-W ($\overline{QRW}$) is enabled by the positioning of front panel switches, and is used by the Sequence Logic (2300) board to prevent sequencing in those switch positions and to disable the FAIL latch for the OHMS switch position.

Pattern Generator, 2500

2.36 The purpose of the Pattern Generator board is to develop the bipolar and selected unipolar pulses needed by the CE-80A/CE-80B to determine the operating performance of repeaters and line sections of a T1, T1C, T148 (T148C) or Duobinary carrier span line.

2.37 Pattern generation starts with the input of the PCM CLK signal at P1-P. This signal is from the clock oscillators on the Clock Osc/QRSS (2600) board, and is two times the normal T1, T1C, T148 (T148C), or Duobinary clock frequencies. Flip-flops U22A and B, U21A, U13A and B are a clock count down circuit to divide the 4.74 MHz T148 input PCM CLK down to 1.58 MHz (U22A pin 9 and U22B pin 12), 790 kHz (U21A, pin 12), and 2.37 MHz (U13A, pin 12 and U13B, pin 9) for T148 timing. When the 4.728 MHz T148C PCM CLK is used in place of T148, the division is 1.576 MHz at U22A pin 9 and U22B pin 12, 788 kHz at U21A pin 12, and 2.364 MHz at U13A pin 12 and U13B pin 9.

2.38 The PCM CLK input also goes to the 14B and C, U21B, U12A and B, U28A, B and C clock select circuit. This circuit develops two outputs. The first clock select circuit output is from U12B, pin 4 and is either one-half the PCM CLK input frequency (for Duobinary system testing) or the PCM CLK frequency itself (for other systems). This output is used for timing on the Pattern Generator/Pulse Driver board. The second output is from U28C, pin 6 and is the QRSS CLK to the Clock Osc/QRSS board 20 bit register input. The input to U28C is either 1.58 MHz from U28A, pin 11 or one-half the PCM CLK from U28B, pin 3. The output of the 20 bit shift register is returned to the Pattern Generator/Pulse Driver board at P1-S (QRSS DATA) and used to develop the MEAS 1, MEAS 2, MEAS 3 pulse patterns.

2.39 As an example of pulse pattern generation assume the CE-80A/B is generating a MEAS 1, pulse period 11 signal. To begin the sequence, binary counter U24 will start at some undetermined number and count up with each clock input until it reaches a maximum count of all 1's. When the next clock pulse occurs, the counter will be reset. This causes the counter Carry Out function to go High, setting flip-flops U4A and B. U4B resets itself at the next clock pulse, while U4A is reset as follows. The binary counter starts counting up (see Table 2-1 and Table 2-2) with each clock input from U18A, pin 9. If the signal was a MEAS 2 or MEAS 3 signal, U25A, pin 6 would go Low when U24 (QA) output was set. This would cause U4A to be reset after being set for 2 clock periods. Since the signal selected is a MEAS 1, pulse period 11, gate U25A will be inhibited, and gate U10A, pin 11 will go Low when the count causes

U24 (QB) to set. This Low resets flip-flop U4A after 3 clock periods. Also at the setting of U24 (QB), if the system tested is not Duobinary, gate U10C, pin 6 will go Low and enable the LOAD input to U24, pin 9. With LOAD enabled, the preset pulse period inputs to U24 at pins 3, 4, 5 and 6 will be loaded into the counter. If the system under test is Duobinary, gate U10C, pin 6 will be disabled and the LOAD input to U24 enabled when U24 (QC) output is set. The counter will now count up from the loaded "preset state" to a count of all 1's, when the process is repeated with another Carry Out pulse. The preset loading count is shown in Table 2-3.

Carry Out	Qd	Qc	Qb	Qa	Load	Comment
0	x	x	x	x	0	Turn-on
↓	↓	↓	↓	↓	↓	
0	1	1	1	1	0	
1	0	0	0	0	0	
0	0	0	0	1	0	
0	0	0	1	0	1	Load
0	1	x	x	x	0	Preset
↓	↓	↓	↓	↓	↓	
0	1	1	1	0	0	

Table 2-1. U24 Binary Counter T1, T1C, T148 Count Sequence

Carry Out	Qd	Qc	Qb	Qa	Load	Comment
0	x	x	x	x	0	Turn-on
↓	↓	↓	↓	↓	↓	
0	1	1	1	1	0	
1	0	0	0	1	0	
1	0	0	1	0	0	
1	0	0	1	1	0	
1	0	1	0	0	1	Load
1	1	x	x	x	0	Preset
↓	↓	↓	↓	↓	↓	
0	1	1	1	1	0	

Table 2-2. U24 Binary Counter Duobinary Count Sequence

C1	B1	A1	Pulse Period
0	0	0	11
0	0	1	10
0	1	0	9
0	1	1	8
1	0	0	7
1	0	1	6
1	1	0	5
1	1	1	4

Table 2-3. PPBCD Preset inputs to U24.

2.40 The output of U4A pin 8 is a series of data pulses which are either 2 or 3 pulse periods long. This means they consist of either two or three consecutive logical "1's". Other circuitry on the Pattern Generator/Pulse Driver board will cause every second logical one in the data pulses to be inverted in polarity so that consecutive ones are alternately positive and negative. This gives the pulse doublets and triplets needed for PCM Fault Line testing.

2.41 When the Carry Out pulse is generated by U24, it sets flip-flop U4B for one clock period. The Low at U4B pin 13 will preset U16A so it is ready to start in the correct polarity. The High U4B pin 12 output will either preset or clear U8A, U16B, and U8B (through gates U9B and C) depending on the polarity of the audio signal as divided down by the U17A, U17B divide-by-4 circuit, so they are also preset to the correct polarity. Now the data pulses for U4B pin 8 are input to the 4 bit shift register (by error inject gate U3B) in known polarities and alternately set and reset U16A and U8A so that consecutive "ones" will have opposite polarity outputs. The clock inputs to U8A, U16B, and U8B are at two times the system clock frequency for T1, T1C, and T148 (T148C) to allow the signal to return to zero between pulses. Since there is no return to zero for Duobinary pulses, its clock input to U8A, U16B, and U8B is at the system frequency. Gates U3C and U3D are inserted in the shift register data stream to inject bipolar violations (by inverting their input pulse polarity during BPV CMD from the Clock Oscillator/QRSS board). The data pulses then go to the T148 QRSS Select gates U1A, U1B, U1C, U2B, U2C, U7A, U7B, and U7C.

2.42 Also into the T148 QRSS Select gates is the output data from the T148 QRSS generator circuit. Three selected bit outputs from the 20 bit shift register (on the Clock Oscillator/QRSS board) plus the output of the pattern generator circuits on the Pattern Generator/Pulse Driver board are input to Programmable Read-Only Memory (PROM) U26. The outputs of U26 are in two groups of three. One is for positive polarity output pulses, the other for negative. They are loaded into registers U20 and U27 when their pin 6 MODE input is a logical one, and then shifted through the registers at the T148 clock rate. As each output pulse is shifted through the register pin 11 (QC) output, it is gated through U12C and U12D to T148 QRSS Select gates. The U12C and U12D outputs also go to the U6 disparity control counter. If the difference in the positive and negative polarity outputs reaches four, QD (U6 pin 7) will be set and cause gate U5A pin 6 to insert an additional pulse into the U26 PROM input at pin 10. This will reduce the T148 disparity counted at U6. U5A pin 6 is also used to inject T148 BPV pulses from the Clock Oscillator/QRSS board into the T148 QRSS generator circuit.

2.43 Circuit operation as described above is identical for T148 and T148(C). Only the system clock frequencies will differ.

2.44 The outputs of T148 QRSS select gates U1C and U7C determine the direction of current through output transformer T1 of the Bipolar Pulse Driver circuit, and thus the output pulse polarity. See Figure 2-2.

2.45 When U1C pin 6 goes High, it is felt at the input of inverters U23A and U23C. The inverted High through U23C is felt at the base of Q5 as

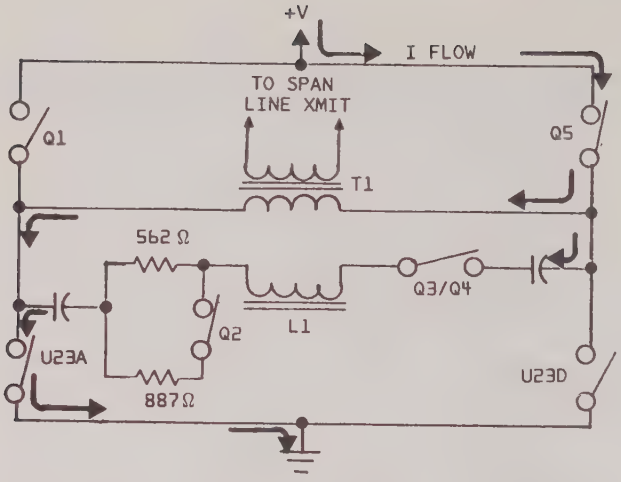


Figure 2-2 (a). Bipolar Output Pulse Polarity Switching (for negative pulse and T148 kick)

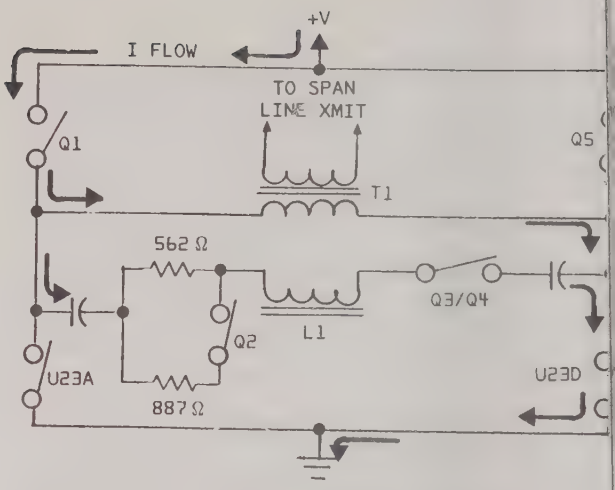


Figure 2-2 (b). Bipolar Output Pulse Polarity Switchir (for positive pulse and T1 kick)

a Low, turning Q5 ON. Current flows through the Q5 emitter to collector and to pin 1 of T1. It goes through T1 to the Low at the U23A output (set by the U1C pin 6 output). When U7C pin 6 goes High, it is felt at the input of inverters U23B and U23D. The output of U23B turns ON Q1, causing current to flow from emitter to collector and to pin 7 of T1. It goes through T1 (from pin 7 to pin 1) to the Low at the U23D output (set by the U7C pin 6 High output being inverted).

2.46 Voltage regulator U15 sets the output bipolar pulse amplitude and is adjustable by R7.

2.47 Afterkick is an important part of the T1 and T148 output bipolar pulses. A Low at P1-8 (T1 KICK) turns ON Q3, Q4 transistor pair and causes inductor L1 to initially pull additional current through T1. This current is stored in L1 until the bipolar output pulse switches polarity. The additional current causes an overshoot on the trailing edge of the output pulse. Likewise, when P1-7 (T148 KICK) goes Low, it turns ON Q2 and Q3, Q4 and stores additional current in L1 for a T148 bipolar output pulse afterkick.

Sequence Logic, 2300

2.48 The Sequence Logic board is the heart of the CE-80 Automatic PCM Fault Locating Test Set. The signals developed here are the commands which control all operations of the Test Set, and the sequence in which they are done.

2.49 Clocking for the board is 3.77 Hz from the Receiver/Converter (2100) board. This clocking assures that all functions of the board occur at the proper time for synchronous operation of CE-80 circuits.

2.50 There are eight test states defined by the Sequence Logic state counter circuits. See Table 2-4. Each test state requires a specific time interval to perform its function, and this is provided by the sequence timer circuits. The pulse period counter circuits define the pulse period selected for testing during test state 7, and store pulse period data for subsequent testing. All other circuits on this board provide input and output gating and amplification of the command signals.

2.51 The state counter consists of Up-Down counter U20, BCD-to-Octal Decoder U25, and the 1 of 8 Data Selector U30. Counter U20 will start in the all zero condition, and is cleared by U6, pin 11 High input. The output of U6 will go High if the P1-1 RST signal goes Low (the front panel RESET pushbutton is activated), or if the P1-31 QRW/OHMS input from the Clock Osc/QRSS (2600) board is Low to disable the sequencing circuits while the FAULT LINE RECEIVER/PCM GENERATOR switch is in the PCM GENERATOR positions.

2.52 Up-Down counter U20 is advanced by NOR gate U15 pin 4 to the U20 pin 5 "up" terminal. The inputs to U15 come from the Fail Gating circuits "Fail" output of U13 pin 12, and the pin 12 or pin 13 inputs from the U25 state 7 (pin 4) output and advance clock gating from the clock select gate of U3 pin 10. The inputs to U3 pin 10 are the manual clock advance, from the front panel ADVANCE pushbutton to P1-A, or the automatic clock advance from U1 pin 9. The automatic clock into U1 pin 2 is the 3.77 Hz Clk input at P1-B. This clock will automatically advance the state counter to the next state unless inhibited by one of the other inputs to the gate. The input from U11 pin 10 will inhibit the advance if the FAULT LINE RECEIVER/PCM GENERATOR switch is not in the AUTO position, and if the Pulse Period Counter U18 is in the all "ones" condition (Pulse Period 4), which will cause U11 pin 6 to be Low. The U11 pin 10 output will also inhibit the automatic advance of the state counter until the proper time interval is available. The input to U11 pin 11 comes from the U30 pin 14 "Z" output. The X 0 to X 7 inputs to U30 are connected to the proper time intervals for each state X 0 to X 7 (respectively) of the state counter. Each state's interval is tied to the U30 "Z" output as it occurs.

Table 2-4. CE-80A/CE-80B Test States

STATE	MEASUREMENT	DESCRIPTION
0	Idle Noise Measurement	Send QRSS. Enable NSY EN after 0.4 seconds. Go to STATE 1 after 0.53 seconds.
1	Range and Acquisition (Reset Timer)	Send MEAS 1, PP 11. Start timer. If no DET AUDIO by 6.6 seconds, then END TEST. If DET AUDIO, then enable State Counter to go to STATE 2.
2	One Clock Period Stabilizing Time (0.265 seconds)	Continue MEAS 1, PP 11.
3	Enable S/N Measurement. Sample R Level and Enable Analog Meter (Reset timer)	Continue MEAS 1, PP 11. Enable S/N measurement (allows Meter Damping to activate). Sample and Hold reference level; activate ±4 dB FAIL Limits; activate analog meter for 2.4 seconds viewing period. Go to STATE 4.
4	MEAS 2 Balance Test	Send MEAS 2, PP 11. Activate ±2 dB limits about reference. After 0.53 seconds go to STATE 5.
5	MEAS 3 Balance Test	Sample and Hold MEAS 2 level. Send MEAS 3, PP 11. Activate ±2 dB limits about reference. Activate ±1 dB limit about MEAS 2.
6	Update Reference (Reset Timer)	Send MEAS 1, PP 11. Sample and Hold reference; activate ±4 dB limit; activate analog meter after 1 clock. After next clock go to STATE 7.
7	Pulse Period Tests	Send MEAS 1, PP 11 through PP 4. Do Last Sample for first five milliseconds of succeeding PP. Activate the ±4 dB limit about reference, and +2 dB, -1 dB limit from Last Sample. Step through PP 11 to PP 4 at 0.53 second intervals. Set END TEST.

2.53 The final inhibit to U1 pin 1 is the FAIL signal from U23 pin 11. It will go High and inhibit the automatic clock advance if the Fail Lmts input at P1-D sets latch U4, or if the QRW/OHMS input at P1-31 shows that front panel switches are not in the correct position. The Fail output at U23 pin 11 also goes to the U10 pin 8 input of the Fail Gating circuits. The U10 pin 10 output will go Low if there is a Fail output (High) from U23 pin 11, and the State Counter is not in State 7 (U9 pin 2 High). If the counter is in State 7, and there is a detected Fail (U7 pin 11 Low) condition, U15 pin 10 will go High, and there will be a Low END TEST signal at P1-3 output.

2.54 The Sequence Timer circuits consist of BCD Up Counter U35, gate latches U34 and U40, shift register U39, and assorted gating. The timer circuit input at U35 pin 9 is the 3.77 Hz clock input from P1-B, and the sequence timing is derived from a count-down of that frequency through the timer circuits. The timer sequence starts with the State "0" idle noise measurement. When State "0" is completed (after 2.7 seconds) and at the beginning of State "1" (U32 pin 10), the Timer Reset, U36 pin 10, will reset the timer output and restart the timer sequence. The Sequence Timer circuit develops the time intervals used to define each of the eight test states (State "0" to State "7"). The intervals developed are: U35 pin 11 is .53 second (to latch U40 pin 6), U35 pin 13 is 1.325 seconds, U35 pin 14 is 2.387 seconds (also goes to the 2.387 second latch U34 pin 13), and the U35 pin 6 time interval is 20.935 seconds which goes to latch U40 pin 9. The 1.325 and 20.935 second signals are used by U39 to develop additional time intervals of 3.975 seconds (U39 pin 4), 6.6 seconds (U39 pin 3), and 126 seconds (U39 pin 2). The 6.6 second time interval is used in State "1" to look for a detected audio signal (BLANK at P1-P). If not found, the timer will be reset and the END TEST LED will light. The 126 second time interval is the 2 minute time-out for CE-80 testing. If the next fault line filter is not tested within two minutes for any reason, the test cycle will be automatically reset and started over again due to normal current leakage on the Sample and Hold capacitors of the Synchronous Detector board.

2.55 When the test sequence reaches State "7", the U9 pin 2 output to U18 pin 14 will go Low and remove the count inhibiting clear input to the U18 Pulse Period Counter. Inputs to the counter are from U23 pins 3 or 4, and will cause the counter to be counted up (if the front panel FAULT LINE RECEIVER/PCM GENERATOR switch is in AUTO or MANUAL) or counted down (switch is in the REVERSE PULSE PERIOD position). When counted up, the Pulse Period Counter will advance through states 0 (for a Pulse Period 11 output) to state 7 (for Pulse Period 4 output). As the counter goes through the Pulse Period count, drivers U17 pins 2, 4, and 6 light the LEDs associated with the Pulse Period count presently held. When the

CE-80 LINE FILTER switch is turned to the next filter to be tested, latch U2 will set flip-flop U7 pin 15. This enables the U3 pin 11 gate to clock the U18 output into the U16 storage register, thus storing the last Pulse Period count to be compared to the next filter's count. While the count is held in the U16 registers, the U16 pin 10 output enables the Blink circuits for the LED showing the last Pulse Period count and the LED associated with that count will blink.

2.56 Also during the State 7 Pulse Period count, one-shot U36 will enable the P1-Y Last Lmts signal which causes the Synchronous Detector board Sample and Hold circuits to sample the last Pulse Period level to compare against the next. Again, the U36 output is not a Pulse Period sample itself, but enables the sample circuits to make the sample at the correct time.

LPF/Audio Generator, 1200

2.57 The LPF/Audio Generator board is used to generate the audio frequencies needed to interrogate fault line filters for testing. It also contains low pass filters to remove unwanted components from audio signals received from fault lines at the front panel FAULT LINE RCV jack.

2.58 The audio oscillator consists of U1 and associated components. The audio frequency is selected by the front panel LINE FILTER switch, which makes one of the resistor pairs R25-R47 the frequency determining component of the oscillator. The oscillator output is four times the needed frequency, and must be later divided down to the correct output. This provides the necessary phased signals to operate the Synchronous Detector circuits. The audio frequencies can be adjusted to within limits by R59. Saturating switch Q1 squares the audio oscillator output.

2.59 Fault line active filters U2A and U2B are used to filter the input audio received at the front panel FAULT LINE RCV jack and amplified on the RECEIVER/CONVERTER board. The filter center frequency is selected by the position of the LINE FILTER switch, which selects the frequency determining resistors R1 - R12 (for filter U2B and R13 - R24 (for filter U2A)

2.60 Section E of the LINE FILTER switch is used to reset the testing sequence logic when the switch is changed from one filter to another. This assures that automatic testing will always begin at the start of the test sequence for each filter interrogated.

2.61 The FAULT LINE RECEIVER/PCM GENERATOR switch on this board has 2 sections. Section A applies power to the LED DISPLAY board when the switch is in the AUTO, MANUAL, or REVERSE PULSE PERIOD position to allow the display of received test data. Section B provides logical enabling signals to CE-80A circuits when in each of the 7 FAULT LINE RECEIVER/PCM GENERATOR positions.

Synchronous Detector, 2200

2.62 The Synchronous Detector board takes the amplified high level audio (HL AUD) from the Receiver/Converter PC board, measures its level with respect to a previously sampled reference level, and displays the signal difference on the CE-80 analog meter.

2.63 The HL AUD comes onto the board at P1-7 and goes to amplifier U21 (for Aud Mon out) and gain compensation amplifier U14. Gain resistors R19-R36 are selected by switches U13, U20, and U26 from the decoded output of U27. This is to correct the output level of amplifier U14 for level differences caused by changes in the pulse period or when changing from MEAS 1 to MEAS 2 or MEAS 3. The pulse period code from the Sequence Logic board comes into the Synchronous Detector board at P1-10, 11, and 12 while MEAS 2 and MEAS 3 data are input at P1-U and V. MEAS 1, Pulse Period 11 data comes in at P1-13 to the U27 Decoder pin 3 (Q0) output. The gain compensated output of U14 is then output through buffer U14 to FET switches Q5 and Q13, and the RMS Detector circuit of U3.

2.64 FET switch Q5 is part of a sampling phase detector circuit which samples a narrow pulse of the audio frequency from U14. The astable multivibrator VCO, Q10 and Q11, oscillates at a frequency four times the transmitted audio frequency received at P1-X. This is done by comparing the VCO output (divided by four in U5) to the transmitted audio AUD FREQ in at connector P1, pin X. The AUD FREQ input goes to one-shot U24, whose output pulse drives the U23 UP-DN Counter count down input, pin 4. The VCO frequency, divided by four, goes to one-shot U16, which drives the U23 count up input, pin 5. Counter U23 is set up in the circuit so that for every five excess count down (CD) pulses the counter will generate a Borrow (BW) output, and for every six excess count up (CU) inputs it will generate a Carry (CY) output pulse. A Borrow output triggers one-shot U16 pin 2, which turns on switch Q2, Q4 and applies a +12V pulse to the junction of R41, C13 through resistor R13. Likewise, a Carry output triggers one-shot U24 pin 2, turning on switch Q1, Q3 and applying a -12V pulse to the R41, C13 junction through R13. If there are more Carry pulses than Borrow Pulses (meaning the VCO frequency is too high), C13 will take on a negative charge and the VCO frequency will decrease. If there are more Borrow pulses (VCO frequency is too low), C13 will take on a positive charge and increase the VCO frequency. The further the VCO frequency is from the transmitted (AUD FREQ) input at P1-X, the more Carry or Borrow pulses there will be and the more positive or negative the voltage across C13. As the frequencies get closer together, there will be fewer pulses, and the voltage across C13 will decrease until the VCO is locked to the correct frequency. At this point there will be zero volts across C13.

2.65 Since the VCO oscillates at four times the transmitted frequency, dividing it by four in U5 is essentially the same as dividing into four equal parts the final audio frequency. Then if cer-

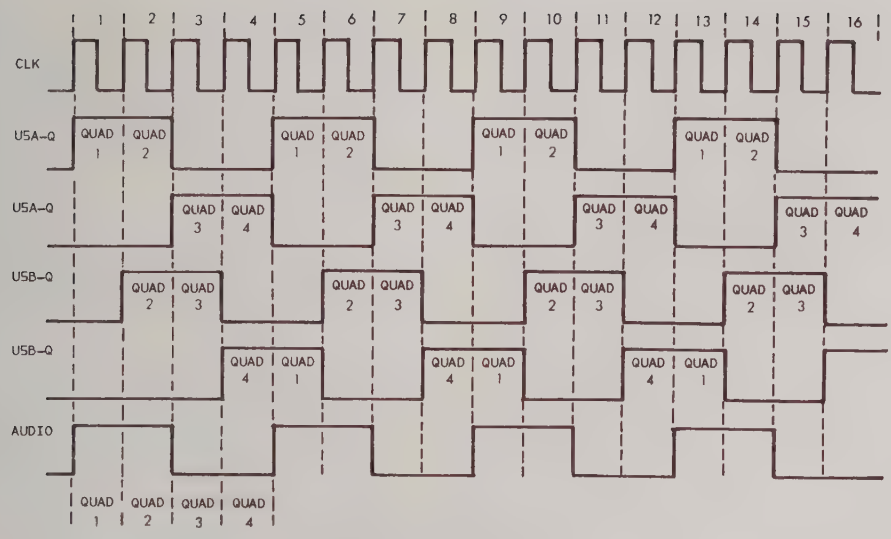


Figure 2-3. Quadrature Divider Timing

tain quadrants of the audio are to be selected, it can be done by selecting different outputs of U5. This is done by the U5 pin 13 output. The leading edge of this output is at the beginning of quadrant 3 of the audio frequency, or its zero crossing as it goes from positive to negative. This leading edge triggers one-shot U4 pin 13, turning on switch Q9, Q8 and enabling the gate of FET Q5. The sampled pulse of the U14 output is stored on C12. Since the sample was at the audio frequency zero crossing, the voltage stored on C12 chould be nearly zero. However, if the input frequency is not correct, the sample will be either above or below the zero crossing causing a positive or negative voltage to be stored on C12. This voltage is buffered through U15 to the inverting input of U6 where it is compared with the voltage stored on C13. If they are both zero the VCO becomes locked. If not, the voltage difference is buffered through U7, Q6, Q7 to the VCO error control input to increase or decrease the VCO frequency.

2.66 The U5 pin 8 output to one-shot U4, pin 10 selects a sample period which is in the next quadrant to that selected by U5 pin 13 above. The pulse from U4 pin 5 turns on switch Q16, Q15 enabling the gate of FET Q13 for a pulse period which is at the peak of the audio input from U14. The sample is stored on C19 and is a measurement of the audio input amplitude. The sample is buffered through U10 to the lowpass filter of the U2 circuit, which filters out noise and harmonics on the audio signal. The U14 audio output signal also goes to U3 which detects the average value of the signal level. This signal is unfiltered and contains all noise and harmonics of the signal which were received. The U3 output signal (S+N) and the U2 filtered output sample (S) levels are compared in U1 and the difference output of U1 pin 2 turns the FET Q14 on or off. If the S+N output of U3 exceeds the S level of U2 by an amount set by the R78 damping threshold potentiometer, FET Q14 is turned off and the filter input resistance is changed from R68/R69, or approximately 100 K ohm, to the 1 Meg of R68. This reduces the filter bandwidth by about 10 (from 1.6 Hz to about 0.16 Hz bandwidth), which reduces the amount of noise through the circuit. The reduced bandwidth increases the response time of the filter circuit, however, to allow the additional time necessary to settle at the reduced bandwidth. This shows up on the CE-80 as an increase in the time needed to test one fault line filter section from 10 seconds to about 40 seconds.

2.67 The filtered audio output signal from U2 also goes to the U25, U17 log converter circuit. It converts the linear signal's amplitude information to a logarithmic output for display on the CE-80 meter. The use of U17 utilizes the current versus voltage characteristics of transistor junctions to provide a logarithmic conversion of the signal. The signal is then taken from the output of U25 pin 7 (point E) to the point E at the R123, R124 (MTR) junction. Here it is used as a comparison signal to both U9 amplifiers.

2.68 The comparison signals to U9 come from the sample and hold circuits of U12 and U19. The control input to U18 is the REF LMTS signal from the Sequence Logic board, and is the logic selecting the MEAS 1, Pulse Period 11 signal period. During this period, the input signal value at U18 pin 8 is stored on C23 as a reference. Leakage from this reference capacitor is the reason for the two-minute time-out limit between test periods. If refreshed within two minutes, the reference will be correct to within 0.1 dB. This reference is buffered through U12 to the analog meter positive side. The input signal which passes through the R124 MTR control to the analog meter negative input will then cause a difference of potential across the meter equal to the difference between the two signals. Since this signal is compensated to always equal the reference, the only difference will be the losses caused by the tested line, and this is displayed on the meter. The U18 pin 5 control input is also from the Sequence Logic board,

and stores on C27 each measured pulse period value as a reference for its following compensated pulse period input. It also references the MEAS 2 input to be used for measuring its value difference from the following MEAS 3 input. These sequentially stored references are used to compare the measured input signal against reference values to determine if the input has exceeded any of the CE-80 limits for that measurement. The references stored on C23 and C27 are buffered through U12 and U19 respectively, and applied to the comparators of U9. The pin 7 and pin 1 outputs of U9 are the difference values between the two signals. If the differences exceed values set by the divider circuits on U8, the U8 output corresponding to the exceeded mode will cause the connector P1 pin W Fail Lmts signal to set the Fail Latch circuit on the Sequence Logic board.

2.69 The CE-80 Ohmmeter function is performed by the four U29 voltage threshold comparators. They test the input line resistance by measuring the voltage drop across resistive dividers using the line resistance as one of the divider values.

Receiver/Converter, 2100

2.70 The purpose of the Receiver/Converter board is to accept the fault line input signal and condition it for testing and display by other CE-80 circuits.

2.71 The fault line input is received at P1 pin 19, 20 of the board. The input is adjusted for common mode signal rejection by R21, and buffered by Q3, Q4 before being applied to differential amplifier U29, pins 2, 3. The output of differential amplifier U29, pin 1 goes to two high pass filters, U29 pin 5 and U21, pin 3 to remove low frequency hum and noise. The U21 pin 1 output then goes to J2, pin 6 where it becomes the input to the LPF/Audio Generator (1200) board. It also goes to amplifier U20 pin 6. Output U20 pin 7 feeds the 3 kHz lowpass filter input of U20 pin 3. The noise is negative limited by CR3 and CR4 and applied to level averaging capacitor C17. If the average noise level at threshold detector U28 pin 9 exceeds the threshold set by R33 and R36, output U28 pin 14 will go positive, setting latch flip-flop U36 pin 11. This turns on switch Q5 and the NOISY FAULT LINE LED.

2.72 The output of the LPF/Audio Generator board is returned at J2 pin 9 and applied to the first of three auto-ranging amplifiers, U21 pin 5, and dual Op Amp U22. Gain for the three auto-ranging amplifiers is set by BCD-Decimal decoder IC, U6, which selects the amplifier's gain determining resistors through U7, U8 gating to quad bilateral switches U14, U15, and U16.

2.73 The BCD input to U6 is taken from the Synchronous Decoder Up-Down counter, U5. The BCD output of U5 is caused to count, or "range" up by the setting of the latching flip-flop U13 pin 3. Down-ranging is done by setting latching flip-flop U12 pin 11. Up-ranging of U5 is disabled by U12 pin 10 output when the ranging circuits have reached the maximum 90 dB. Up-ranging is also disabled if the test sequence is not in MEAS 1, PP 11 (detected at U13 pin 6 from P1-P). Range latching flip-flops U12 and U13 are set by comparing the P1-F detected audio input to a set reference in voltage comparator U11, and reset by clocking from comparator/inverters U19 pin 14 (for up-range latch) and U19 pin 13 (for down-range latch). The clocking frequencies are from the U31 pin 3, 4, 6, and 12 outputs and are derived from the P1-5 193 kHz Clock input to the Divide-by-400 circuits of U23 and U17. The U31 pin 3 (3.77 Hz) output also goes through P1-10 to the Sequence Logic (2300) board for clocking.

2.74 The U31 pin 12 output clock (241.25 Hz) is used for preset loading and counting of the CE-80 level display counters, and goes to three places. It first goes to the one-shot multivibrator U32 pin 12. This one-shot enables preset loading of the U35 Programmable Read Only Memory (PROM) output into the tenths (U34) and units (U33) counters, and of the U5 decode counter output to the tens (U4) counter. The 241.25 Hz clock also goes through driver U9 pin 4 to switch Q8, Q7. This switch gates FET switch Q6 on and off to allow the zero reference voltage, set by R83 and amplified through U1, to be applied to the exponential decay network at U2 pin 2. The DET AUDIO input at P1-F is the threshold which when crossed by the decaying voltage at U2 pin 2, will cause gate flip-flop U18 to reset. Flip-flop U18 is set by the third output of the U31 pin 12 (241.25 Hz) clock from driver U9 pin 3.

2.75 The DET AUDIO input also goes to U28 which determines if the level exceeds the zero reference level set by R83. If so, it turns on switch Q9 and lights the OVLD LED on the CE-80 front panel. Since the 241.25 Hz clock and the zero reference voltage are both constant, the only variable is the DET AUDIO input. It's value will determine at which point along the exponential decay curve U18 will be reset, and therefore the "set" time duration.

2.76 The set U18 flip-flop enables gate U18 pin 9 so that the 96.5 kHz output of U23 will be gated through U18 pin 10 to the U10 pin 9 one-shot input. The number of counts input to U10 pin 9 is determined by the duration of the U18 set time, and can be up to 400 counts. The U10 pin 12 one-shot output is serially input to counter U34 at the pin 5 count-up input. For every 10 counts into U34, pin 5 the counter generates a carry-out pulse to U33 pin 5 count-up input, which in turn generates a carry-out pulse for every 10 pulses to U24 pin 2. The output of U24 pin 11 will allow the U33 pin 12 carry-out to enable the U4 pin 5 count-up input if it is not Load time (U32 pin 9 HIGH) and the CE-80 is in either the MEAS 1, PP 11, MEAS 2, or MEAS 3 measurement mode (U32 pin 7 LOW).

Display, 1100

2.77 The purpose of the Display board is to convert processed CE-80 output data into a form compatable with the display circuits, to allow a meaningful output to be presented for display.

2.78 Inputs to the digital display seven segment LED indicators U3, U4, U5 come from the Receiver/Converter (2100) board as digital binary coded decimal (BCD) data. The data is converted by the BCD-to-seven segment decoder/driver ICs U1, U2, and U6 to display the decimal numbers on the indicator LEDs by lighting the correct LED segments.

2.79 The CE-80 Test Status LEDs are controlled by Sequence Logic (2300) board outputs. Pulse Period test status LEDs 4-11 (CR1-8) are lighted by the one-of-ten output of UCs U7 and U8, which are the BCD-to-decimal decoder/driver ICs. Other Test Status LEDs (CR9-15) are lighted by additional Sequence Logic board signals. Switched input power (DIS PWR) is from the LPF/Audio Generator (1200) board and applies power when the function switch is in AUTO, MANUAL, or REVERSE.

Power Supply, 2700

2.80 The purpose of the Power Supply board is to generate the voltages needed for operation of the CE-80A/CE-80B circuits. See Figure 2-4 Power Supply Block Diagram.

2.81 Output voltages are derived from transformer secondary inputs to full-wave rectifiers CR1-4 (for +12V), CR11-14 (for -12V), CR17-18 (for +5V), and Z1 (for the +118V DC active line filter voltage). Ripple on the respective rectified voltages is filtered out by C1, C4, C6, and C8. The unregulated DC is then applied to a series regulating transistor on the rear panel. Voltage regulation is achieved by controlling current through the regulating transistor by varying its emitter-base voltage as shown in the following example of +12V regulator operation.

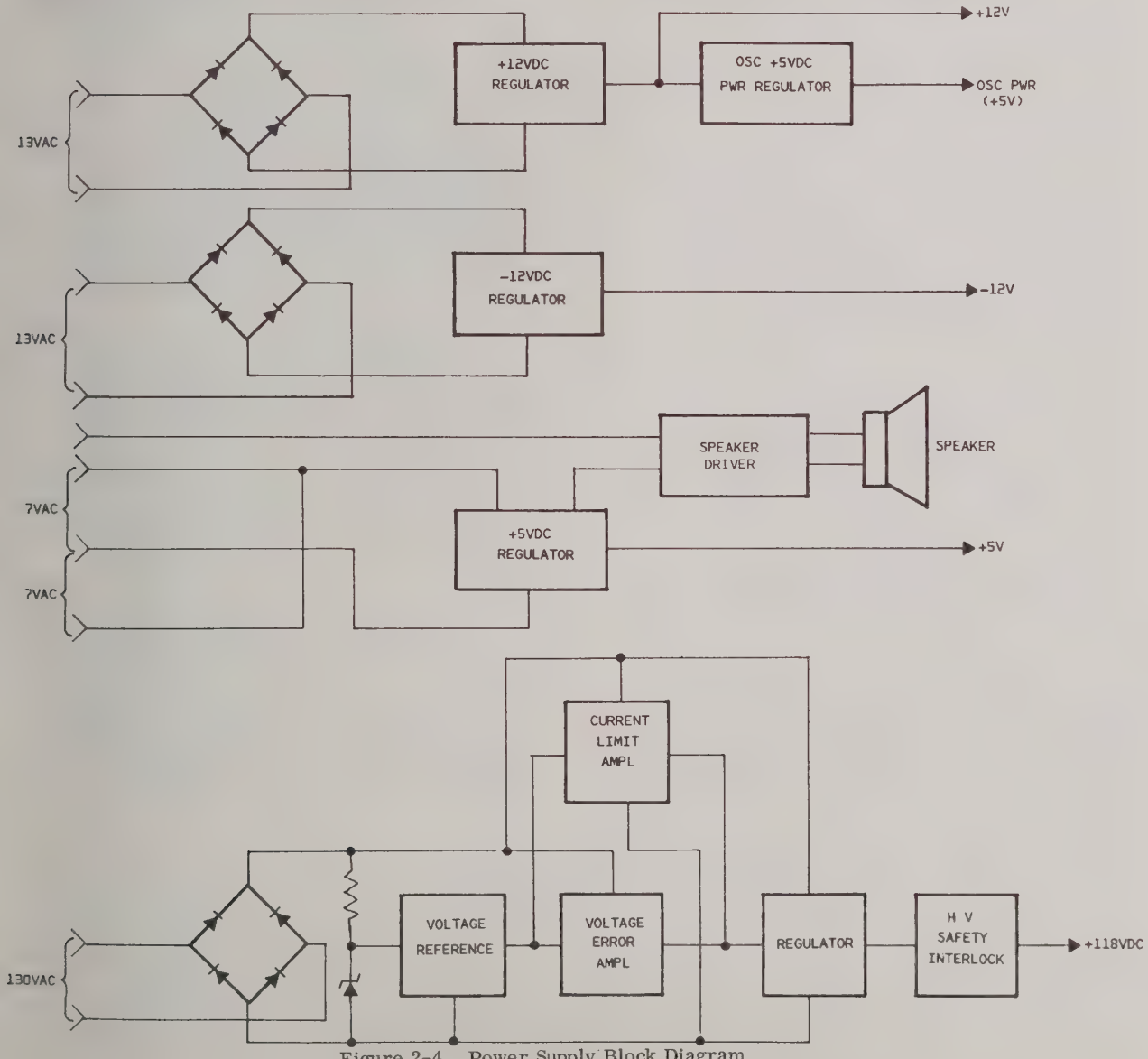


Figure 2-4. Power Supply Block Diagram

2.82 Assume a decrease in the +12V load (i.e., the load requires less current). Since the current available can't change until the regulator responds to the new demand, the +12V output will try to increase. This will cause the voltage drop across reference divider R8, R9, R10 to try to increase and make the voltage sensed at U1 pin 2 inverting input try to go more positive than the non-inverting input reference set at pin 3 by CR10. As the input tries to go more positive, the U1 pin 6 output will try to go more negative. The U1 output level, reduced by the CR8 zener voltage, is applied to the base of Q1, reducing its emitter-base bias. This reduces the current pulled by Q1 through R4. The reduced current reduces the voltage drop across R4 and makes the base of the regulating transistor try to become more positive. Since the regulating transistor is a PNP, a more positive base would reduce its emitter-base bias and reduce the output current to the load. The regulator has now responded to the reduced current requirements to the load, and the voltage will stop trying to increase. Note that during the regulation cycle the +12V output never actually increases. The regulator responded to the attempt to increase and before an increase actually occurred.

2.83 Oscillator power is +5V produced from the regulated +12V by U4. Zener diode CR5 is a voltage pre-regulator which applies power to U1 (when power is first applied to the instrument) until the regulated +12V is available for power. Diodes CR6, CR7, and CR9 are blocking diodes used to separate the regulated output from the unregulated voltage after the initial circuit start-up through these diodes.

2.84 The -12V and +5V regulators operate the same as the +12V regulator except that the reference used in both supplies is the regulated +12V, and there is no voltage adjustment for the outputs. Also, since the regulated +12V is used for the U2 and U3 Op Amps, a start-up circuit (such as CR5 in the +12V regulator) is not required.

2.85 Loudspeaker LS1 on this board is driven by U5, and will give audible signals (when selected at the front panel) if bipolar violations, logic errors, or no input signal is detected.

2.86 The +118V DC High Voltage supply is used to power active fault line filters, and can be added to the board as Option M3. The 130V AC transformer secondary voltage is input to full wave rectifier Z1, and then filtered by C8. This unregulated DC output goes to two places. One is to 6.9V zener CR21 where the 6.9V is used by Q6, Q7 to generate a voltage reference for the non-inverting input to Error Amplifier U6. The unregulated DC also goes through F1, CR20, and current limiting resistor R29 to the pass transistor Q5 emitter.

2.87 Regulation of the +118V DC output is done in the same manner as that for the +12V DC power supply circuits. The base-emitter voltage of regulating transistor Q5 is controlled by Error Amplifier U6, Q8. The output voltage is monitored across voltage divider R42, R43, R44 and input to the U6 inverting input. Here it is compared with the non-inverting input reference, and the Error Amplifier output used to control the Q5 base-emitter voltage, and consequently the current through the pass transistor.

2.88 Four independent safety features protect the operator and CE-80B High Voltage power supply by limiting the output current available. The primary safety feature is the High Voltage Safety Interlock circuit of Q9, Q10, and relay K1. The relay will open the high voltage output line on the board if there is no ground input detected at connector P1 pin 19. This point, called $\overline{\text{HV EN}}$, will be grounded through the sleeve contact of the phone plug cable connected between the CE-80B and active fault line. Since the RCV jack on the CE-80B is isolated from ground, the only ground the cable can find is in the active fault line connection. With no grounded input, transistors Q9 and Q10 will be turned off, and relay K1 de-energized. This opens up the +118V DC output line to connector P1 pin 1.

2.89 The second protective feature on the High Voltage power supply is the Current Limit circuit of U6, Q11. The voltage drop across R45 will cause the emitter bias of Q7 to change until the input voltage at the U6 non-inverting input is equal to the voltage reference set by divider R32, R33 at its inverting input. The correct voltage drop across R45 will occur when the current through the resistor reaches about 15 mA. At this time Q11 will start to turn on and turn on Q4, which reduces the Q5 base-emitter bias and limits the current through pass transistor Q5 to 15 mA.

2.90 The third and fourth protective features are another current limiter and a fuse. Resistor R29 can also cause Q4 to limit the +118V DC power supply output current to a maximum of 25 mA if for some reason (such as a circuit failure) the U6, Q11 circuit doesn't limit the output current to 15 mA. And fuse F1 is in the circuit to protect the board only if the other protective limits are exceeded.

SECTION 3
MAINTENANCE

GENERAL

3.01 This section of the manual contains information necessary to check the performance of the CE-80 and to make recommended field adjustments, and a troubleshooting procedure for locating system problems down to the PC board level.

3.02 The Performance Checks may be used to verify proper CE-80 operation. Adjustment and/or calibration might be required if the performance checks indicate out of tolerance operation.

3.03 If the adjustment procedures fail to correct a trouble, and the cause of the trouble is not readily apparent or easily repairable, it is recommended that the faulty circuit board or complete instrument be returned to the factory or to a service center for repair. Always contact the Cushman Electronics Customer Service Department before returning any equipment. See paragraph 3.20 for procedures.

PERFORMANCE CHECKS

3.04 The following performance checks will test the CE-80 for proper operation within published specifications. If the adjustment procedures given will not return the unit to its specified operational range, or if there is no adjustment given for a specification which is out of tolerance, it is suggested that the factory be notified for assistance and/or shipping instructions.

C E-80 Operational Check

3.05 The CE-80 functions can be checked for proper operation by performing the following checks.

1. Connect the FAULT LINE RCV jack to the SPAN LINE MON jack. Do not connect the SPAN LINE XMIT jack. The MON jack has 900Ω impedance buffering to prevent the output signal from overloading the CE-80 receiver input.

NOTE

With no input signal (input is -100 dBm or below) the digital display will be blanked, dB ERROR meter stays zeroed, the READ LED remains OFF, and after approximately seven seconds the END TEST LED will light. If at any time the RCV input level becomes greater than -100 dBm (before or after the END TEST LED lights) the full test cycle will begin and go to completion even if the level drops below -100 dBm during the cycle.

2. Set the FAULT LINE RECEIVER/PCM GENERATOR switch to AUTO and press the RESET pushbutton. The NOISY FAULT LINE LED will light and remain ON during this test, as limits in the CE-80 are programmed to compensate for line and filter losses which don't occur in the operational test.

3. The CE-80 should now sequence through the MEAS 1, MEAS 2, MEAS 3, and all the MEAS 1, Pulse Period tests before lighting the END TEST LED.

4. Move the TEST FAULT LINE switch to the TIP OR RING GROUND and then the TIP-RING OPEN positions. The FAIL LED should not light.

5. Connect the SPAN LINE MON jack to the PCM SIG IN jack, and set both the SYSTEM switches to the same system.

6. Set the FAULT LINE RECEIVER/PCM GENERATOR switch to the QRSS position, and the BPV/LOGIC switch to BPV. The PULSES LED should be lighted.

7. Switch the FAULT LINE RECEIVER/PCM GENERATOR switch to W/BPV. The PULSES LED should be ON, and the ERROR LED should flash.

8. Place the FAULT LINE RECEIVER/PCM GENERATOR switch to the ALL 1's position. The PULSES and ALL 1's LEDs should light (the OSC OR ALL 1's LED in the CE-80A will light).

9. Set both SYSTEM switches to T1 or T1C. Set the BPV/LOGIC switch to LOGIC. Set the FAULT LINE RECEIVER/PCM GENERATOR switch to W/ERRORS. The PULSES LED should be ON, and the ERROR LED should flash.

Power Supplies

3.06 The following test equipment is required to check the power supply circuit for proper operation. Any equivalent instrument may be used.

Digital Multimeter (DMM) Dana 4300

1. Connect the DMM positive lead to test point 6 (TP 6) on Power Supply (2700) board, and negative lead to chassis ground. Readjust R9 if necessary to read +12.00 ±0.02V DC on the DMM.

2. Connect the DMM positive lead to TP 5. Verify that DMM reads +5.00 ±0.50V DC.

3. Connect the DMM positive lead to TP2. Verify that DMM reads +5.00 ±0.08V DC.

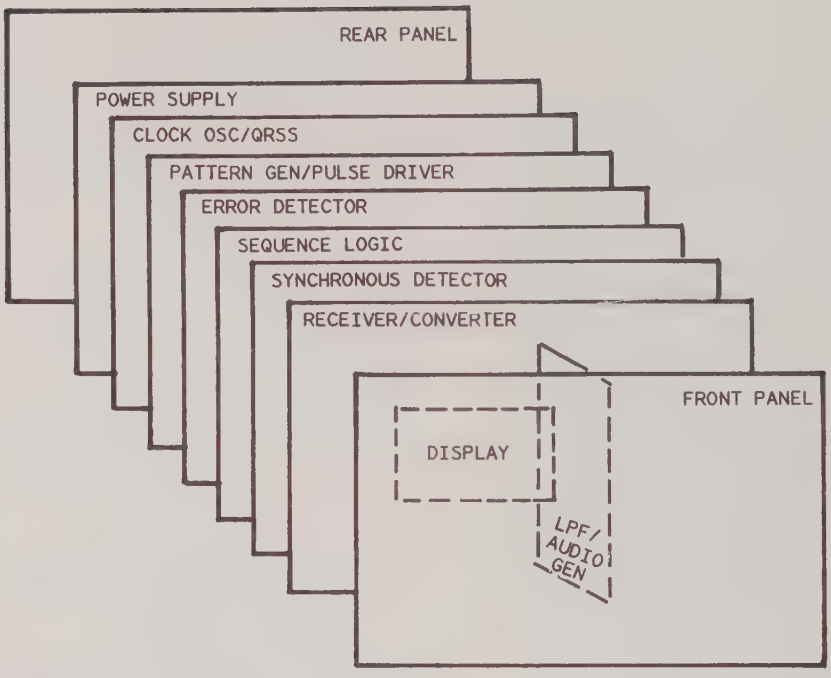


Figure 3-1. CE-80A/CE-80B Assembly Location

4. Connect the DMM negative lead to TP 3 and positive lead to chassis ground. Verify that DMM reads -12.00 ±0.15 V DC.

Clock Frequencies

3.07 The following test equipment is required to check for proper clock frequency operation. Any equivalent instrument m ay be substituted.

Frequency counter	Dana 8020
Oscilloscope	Tektronix 465

1. Set CE-80 controls as follows:

   a. FAULT LINE RECEIVER/ PCM GENERATOR switch to ALL 1's.

   b. Fault Line SYSTEM switch to T1.

2. Terminate the SPAN LINE XMIT output with 100 ohms ±1%. Connect the Dana 8020 counter between the 100 ohm resistor and chassis ground. Adjust the counter trigger as necessary to read the correct clock frequency multiple of 772,000 ±15 Hz. If not, proceed to Step 5.

3. Switch the Fault Line SYSTEM switch to T1C. The counter should read 1,576,000 ±15 Hz. If not, proceed to Step 5.

4. Switch the Fault Line SYSTEM switch to T148. The counter should read 1,185,000 15 Hz. If not, proceed to Step 5.

5. Remove the 100 ohm ±1% termination from the SPAN LINE XMIT output and connect the counter to the Clock Osc/QRSS (2600) board TP 3 and TP4 (ground). Set the Fault Line SYSTEM switch to T1.

6. Connect a X10 probe from the oscilloscope to TP 5 with its ground to TP 8. Adjust C4 for peak signal on the scope (0.9V p-p, typical). Adjust C8 for a reading on the frequency counter of 3.088000 MHz ±30 Hz.

7. Connect the scope probe to TP 7 (ground still connected to TP 8). Change the Fault Line SYSTEM switch

to T1C and adjust C17 for peak signal on the scope (0.6V p-p, typical). Adjust C25 for a reading on the frequency counter of 6.304000 MHz ±30 Hz.

8. Connect the scope probe to TP 6 (ground still to TP 8). Set the Fault Line SYSTEM switch to T148 and adjust C15 for peak signal on the scope (0.6V p-p, typical). Adjust C23 for a reading on the frequency counter of 4.740000 MHz ±30 Hz.

Output Pulse Parameters

3.08 The following test equipment is required to check for proper output pulse parameters. Any equivalent instrument may be substituted.

Oscilloscope Tektronix 465

1. Set the CE-80 Fault Line SYSTEM switch to T1, and the FAULT LINE RECEIVER/PCM GENERATOR switch to QRSS.

2. Terminate the CE-80 SPAN LINE XMIT output with 100 ohms ±1% from connector tip to ring. Connect an X10 probe to each of the oscilloscope's two channels and connect the probe grounds together. Invert the polarity of one channel, set the oscilloscope to the ADD function, and connect the scope probes differentially across the termination resistance.

3. Check that positive pulse amplitude is 3.00 ±0.05V from the baseline. If not, adjust R7 on the Pattern Generator/Pulse Driver (2500) board.

4. Check that the negative pulse amplitude from the baseline is within 0.10V of the positive pulse amplitude, and that the afterkick is within 0.3-0.9 volts baseline-to-peak.

5. Change the Fault Line SYSTEM switch to T1C and check that apparent baseline noise level is less than 0.6 volts p-p.

6. Move the Fault Line SYSTEM switch to T148 and check that the afterkick is between 0.6 volts and 1.2 volts baseline-to-peak.

7. Set the Fault Line SYSTEM switch to DBNRY and check that the apparent baseline noise level is less than 0.6 volts p-p.

Audio Generator Frequencies Check

3.09 The following test equipment is required to check this circuit for proper operation. Any equivalent instrument may be used.

Frequency Counter Dana 8020

1. Connect the counter to TP 5 and TP 6 (ground) on the Pattern Generator/Pulse Driver (2500) board.

2. Switch the LINE FILTER switch to each position from A-M and note that the counter reads within the frequency limits listed in Table 3-1 for each switch position.

3. If adjustment is required, adjust R59 on the LPF/AUDIO GENERATOR (1200) board.

	LIMITS, Hz			LIMITS, Hz	
FILTER	+	-	FILTER	+	-
A	822	838	G	1703	1740
B	917	936	H	1987	2029
C	1037	1059	J	2170	2215
D	1192	1219	K	2388	2438
E	1325	1354	L	2652	2708
F	1492	1524	M	2986	3048

Table 3-1. Audio Generator Frequency Limits

Common Mode Rejection Check

3.10 The following test equipment is required to check for CE-80 common mode rejection. Any equivalent instrument may be used.

AC voltmeter HP 400FL
Audio oscillator HP 204C

1. Connect the test equipment as shown in Figure 3-2. Set the audio oscillator to 4kHz and 0dBm output reading on the AC voltmeter.

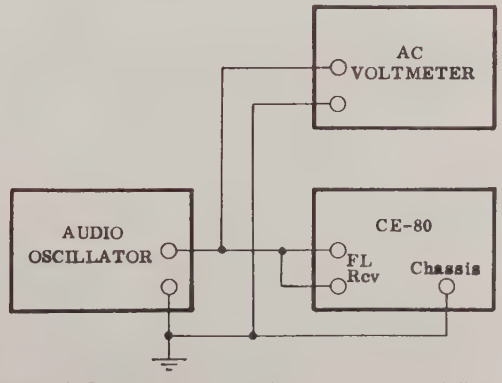


Figure 3-2. Common Mode Rejection Test Set-up

2. On the CE-80 Receiver/Converter (2100) board, remove connector J2 and connect a jumper from its pin 6 (on the board) to pin 9. On the board's test jack J3, connect pin 1 to pin 2. This bypasses the LPF/Audio Gen (1200) board and fixes the front end gain at about 58 dB.

3. Connect the AC voltmeter to the Receiver/Converter board TP 3 and a nearby ground (such as the right side of C27). The AC voltmeter should read less than -2dB.

4. Remove the jumpers installed in Step 2. above.

Receiver Accuracy and Functional Checks

3.11 The following test equipment is required check for proper receiver function and accuracy. Any equivalent instrument can be used.

Frequency counter	Dana 8020
Attenuator, balanced	HP 4436A
Audio oscillator	HP 204C
AC voltmeter	HP 400FL
Pad, balanced, 600Ω/900Ω	-

Note

If a 600Ω/900Ω balanced impedance matching pad is not available, one can be made from standard 1% values as shown in Figure 3-3.

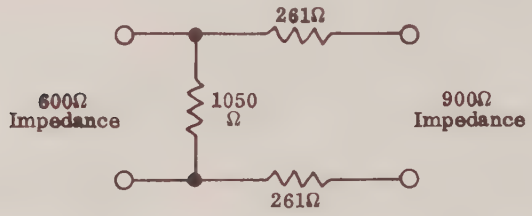


Figure 3-3. 600Ω/900Ω Balanced Pad (4 dB loss)

1. Connect the test equipment as shown in Figure 3-4. Set the audio oscillator carefully to 1508 Hz and -4 dBm on the AC voltmeter. On the CE-80, place the Fault Line SYSTEM switch to T1, the LINE FILTER switch to F, and the FAULT LINE RECEIVER/PCM GENERATOR switch to MANUAL.

2. Set the attenuator to 49.2 dB. The RCV LEVEL should read approximately -59.0dBm on the CE-80 digital display.

3. Go to the MEAS 2 state by pressing the ADVANCE pushbutton. Set the oscillator output for a -10 dBm reading on the AC voltmeter. Change the attenuator to 42.2 dB. The RCV LEVEL should be -58.0 dBm. If necessary, adjust R83 (ZERO) on the Receiver/Converter (2100) board for -58.0dBm level.

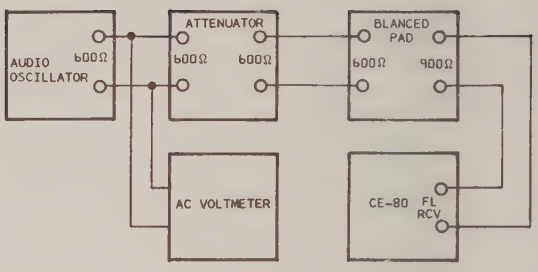


Figure 3-4. Receiver Accuracy and Functional Checks Test Set-up.

Note

The CE-80 FAIL indicator will light during the following tests, but may be ignored. It is lighted due to incorrect levels detected during the sampling period while changing the levels manually.

4. Set the attenuator to 58.2 dB. The RCV LEVEL reading should be -74.0 dBm. If necessary, adjust R88 (GAIN) on the Receiver/Converter board of -74.0 dBm level.

5. On the Sequence Logic (2300) board, short TP 1 to ground to disable the two minute reset timer.

6. Set the oscillator output to a -4 dBm level reading on the AC voltmeter.

7. Change the attenuator in 10 dB steps from -10.2 dB to -80.2dB. The RCV LEVEL on the digital display should read (correspondingly) -20.00 ±0.2 dB to -90.0 dB, ±0.2dB.

8. Set the attenuator for 50.2 dB and note the RCV LEVEL reading. Press the ADVANCE pushbutton to go to MEAS 2. Adjust the oscillator output level for -10 dBm on the AC voltmeter and note that the RCV LEVEL is -6.0 ±0.2 dB from the MEAS 1 reading.

9. Step the attenuator in 1 dB steps from 51.2 dB to 59.2 dB. The RCV LEVEL should read (correspondingly) -67.0 ±0.3 dB to -75.0 ±0.3 dB.

10. Set the attenuator to 49.2 dB. The RCV LEVEL should read -65.0 ±0.2dB. Change the attenuator in 1 dB steps from 48.2 dB to 40.2dB. Note that the RCV LEVEL reading changes from -64.0 ±0.2 dB to -56.0 ±0.2 dB (overrange before -56.0 dB is okay).

11. Set the oscillator output to 832 Hz and a -10 dBm level on the AC voltmeter. Set the attenuator to 40.2 dB.

12. On the CE-80, set the LINE FILTER switch to A, and press the ADVANCE pushbutton to go to MEAS 2.

13. The RCV LEVEL should be -56.0 ±0.5 dBm. Change the attenuator to 49.2 dB and note that the RCV LEVEL now reads -65.0 ±0.5 dBm.

14. Repeat steps 11-13 for each LINE FILTER code, substituting the correct frequency (in Step 11) and code letter (in Step 12) for each code A-M as listed in CE-80 Specifications, Table 1-1.

15. Change the CE-80 FAULT LINE RECEIVER/PCM GENERATOR switch to AUTO and press the RESET pushbutton while observing a watch with seconds indication. The automatic sequence should be completed in 10 ± 1 seconds.

dB ERROR Meter Linearity Check

3.12 The following test equipment is required to check dB ERROR meter linearity. Any equivalent instrument may be used.

Frequency counter	Dana 8020
Attenuator, balanced	HP 4436A
Audio oscillator	HP 204C
AC voltmeter	HP 400FL
Pad, balanced 600Ω/900Ω	-

1. Use the same test set-up of Figure 3-4. On the audio oscillator, set the output frequency to 1508 Hz, and the output level to a reading of -9 dBm on the AC voltmeter.

2. Set the CE-80 Fault Line SYSTEM switch to T1, the LINE FILTER switch to F, and the FAULT LINE RECEIVER/PCM GENERATOR switch to MANUAL.

3. Set the attenuator to 45.2 dB and press the CE-80 RESET pushbutton. When the READ indicator lights, the dB ERROR meter should read 0.0 ±0.1 dB.

4. Adjust the audio oscillator output level for exactly 0.0 dB on the dB ERROR meter, and set the attenuator to 49.2 dB. The dB ERROR meter should read -4 dB (-0.0 dB to +0.1 dB).

5. Decrease the attenuator in 1 dB steps to 41.2 dB and note that the dB ERROR meter follows in 1 dB steps to +4.0 dB (+0.0 dB to -0.1 dB). If necessary, R124 (MTR) on the Synchronous Detector (2200) board can be adjusted to minimize any error.

Failure Limits

3.13 The following test equipment is required to check the failure limits of the CE-80. Any equivalent instrument may be used.

Frequency counter	Dana 8020
Attenuator, balanced	HP 4426 A
Audio oscillator	HP 204C
AC voltmeter	HP 400 FL
Pad, balanced, 600Ω/900Ω	-

1. Use the same test set-up of Figure 3-4. On the audio oscillator, set the output frequency to 1508 Hz, and level to -9 dBm on the AC voltmeter. Set the attenuator to 45.2 dB.

2. On the CE-80, place the Fault Line SYSTEM switch in the T1 position, the LINE FILTER switch to F, and the FAULT LINE RECEIVER/PCM GENERATOR switch to MANUAL.

3. Press the CE-80 RESET pushbutton, and go to MEAS 2 by pressing the ADVANCE pushbutton.

4. Slowly decrease the audio oscillator output level with the vernier control until the FAIL indicator lights. The dB ERROR meter should show -2.0 ±0.2 dB.

5. Repeat Steps 3 and 4 above except increase the audio oscillator output level until the FAIL indicator lights. The dB ERROR meter should show +2.0 ±0.2dB.

6. Press the CE-80 RESET pushbutton, and go to MEAS 2 by pressing the ADVANCE pushbutton. Adjust the audio oscillator output level until the dB ERROR meter reads 0.0 dB.

7. Push the ADVANCE pushbutton to go to MEAS 3. Slowly decrease the audio oscillator output level until the FAIL indicator lights. The dB ERROR meter should show -1.0 ±0.2dB.

8. Repeat Step 7, above except slowly increase the audio oscillator output level until the FAIL indicator lights. The dB ERROR meter should read +1 dB ±0.2 dB.

9. Press the ADVANCE pushbutton to go to MEAS 1, Pulse Period 10. Slowly decrease the audio oscillator output level until the END TEST indicator lights. The dB ERROR meter should read -1.0 ±0.2dB.

10. Repeat Step 9. above except slowly increase the audio oscillator output level until the END TEST indicator lights. The dB ERROR meter should read +2.0 ±0.2 dB.

11. Decrease the audio oscillator output level until the dB ERROR meter reads 0.0 dB. Change the FAULT LINE

RECEIVER/PCM GENERATOR switch to REVERSE PULSE PERIOD. Press the ADVANCE pushbutton to go to MEAS 1, Pulse Period 11. Slowly decrease the audio generator output level until the END TEST indicator lights. The dB ERROR meter should read -2.0 ±0.2 dB.

12. Increase the audio oscillator output level until the dB ERROR meter reads 0.0 dB. Press the ADVANCE pushbutton to go (in reverse) to Pulse Period 11. Slowly increase the audio generator output level until the END TEST indicator lights. The dB ERROR meter should read +1.0 ±0.2 dB.

Meter Damping Threshold and Bandwidth Checks

3.14 The following test equipment is required to check for proper operation of the Meter Damping. Any equivalent instrument may be used.

Noise generator	HP8057A
LPF Fixture	CE# 5611-0212
Dual Power Supply (+12, -12)	Power Designs TW5005
Attenuator, balanced	HP 4436A
AC voltmeter	HP 400FL
Pad, balanced, 600Ω/900Ω	-

1. Connect the test equipment as shown in Figure 3-5.

2. Make equipment control settings as follows:

Noise generator
dB to 8x.x
NOISE to White
IMPEDANCE to 600Ω
LPF Fixture
3kHz FLAT to ON
LINE FILTER to position A
Attenuator
ATTEN to 56.2 dB
CE-80
FAULT LINE RECEIVER/PCM GENERATOR switch to MANUAL

LINE FILTER switch to Position A.

3. On the LPF Fixture, change the GAIN ADJ to read -14.0 dBm on the AC voltmeter. The digital display on the CE-80 should show approximately -70 dBm.

4. Change the CE-80 FAULT LINE RECEIVER/PCM GENERATOR switch to QRSS. Adjust the HP 8057A Noise generator dB controls for -12.0 dBm reading on the AC voltmeter, and note the dB control settings as a reference for the following tests.

5. Set the CE-80 FAULT LINE RECEIVER/PCM GENERATOR switch back to MANUAL. Reduce the noise generator dB controls for 2 dB below the reference setting noted above. The METER DAMPING LED should stay OF most of the time.

6. Check that the CE-80 dB ERROR meter has less than ±0.5 dB peak ripple in the marker's reading.

7. Change the noise generator dB controls for 2 dB above the reference setting. The METER DAMPING LED should remain ON most of the time.

8. Increase the noise generator dB controls setting to 7 dB above the reference setting and note the dB ERROR meter. It should show less than ±0.5 dB peak ripple.

Noisy Fault Line Threshold Check

3.15 The following test equipment is required to check the CE-80 noisy fault line threshold. Any equivalent instrument may be used.

Noise Generator	HP 8057A
LPF Fixture	CE#5611-0
Dual Power Supply (+12V; -12V)	Power Des TW 500
Attenuator, balanced, 600Ω	HP 4436A
AC Voltmeter, 600Ω cal	HP 400FL
Pad, balanced 600Ω/900Ω	-

1. Connect the test equipment as shown in Figure 3-5 except remove the connection from the SPAN MON output of the CE-80 to the LPF Fixture Input B connection.

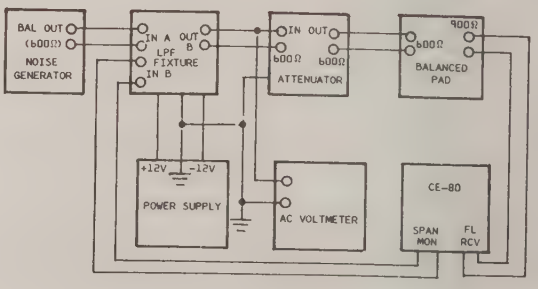


Figure 3-5. Meter Damping and Noisy Fault Line Test Set-up

2. Make equipment control settings as follows:

Noise generator
dB to 115.5
NOISE to WHITE
IMPEDANCE to 600Ω

LPF Fixture
3 kHz FLAT to ON
LINE FILTER to position A

Attenuator
ATTEN to 56.0 dB

CE-80
FAULT LINE RECEIVER/PCM GENERATOR switch to MANUAL

LINE FILTER switch to A

3. Adjust the LPF Fixture GAIN ADJ control for -16 dBm reading on the AC voltmeter. Switch the 3 kHz FLAT to OFF. The AC voltmeter should read about -12.25 dB, which represents a white noise level to the CE-80 of +14 dBrnC.

4. Press the CE-80 RESET pushbutton five times at about one second intervals. The NOISY FAULT LINE LED should light no more than one time.

5. Set the attenuator controls for 52.2 dB. This increases the input noise level to +16 dBrnC. Press the RESET pushbutton five times at about one second intervals. The NOISY FAULT LINE LED should light three or more times.

Ohmmeter Threshold Checks

3.16 The following test equipment is required to check for proper ohmmeter threshold operation. Any equivalent test instrument may be used.

Resistor, ±5%, 1/4W	11K Ohms
	9.1K Ohms
	180K Ohms
	220K Ohms

1. Connect the 11K Ohm resistor across the FAULT LINE RCV jack. Press the TEST FAULT LINE switch to the TIP-RING OPEN position. The FAIL and END TEST indicators should light.

2. Repeat Step 1. with the 9.1K Ohm resistor. The END TEST indicator should light, but the FAIL indicator should remain OFF.

3. Connect the 180K Ohm resistor from the FAULT LINE RCV tip to chassis ground. Press the TEST FAULT LINE switch to the TIP OR RING GROUND position. The FAIL and END TEST indicators should both light.

4. Repeat Step 3. above with the 220K-Ohm resistor. The END TEST indicator should light, but FAIL should remain OFF.

PCM Detector Sensitivity and Function Check

3.17 The following test equipment is required to check the PCM Detector circuits performance. Any equivalent instrument may be used.

Attenuator pad, 100Ω, 24 dB	
Oscilloscope	Tektronix 465

The attenuator pad can be made using two Switchcraft M114B phone jacks, two 113Ω, ±1% resistors, and two 392Ω, ±1% resistors. The parts interconnect is shown in Figure 3-6.

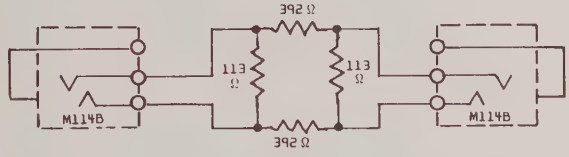


Figure 3-6. 100Ω impedance, 24 dB attenuator test pad.

1. Set the CE-80 FAULT LINE RECEIVER/PCM GENERATOR switch to QRSS, the Fault Line SYSTEM switch to T1, BPV/LOGIC switch to BPV, the PCM Detector SYSTEM switch to T1, and ALARM to OFF.

2. Connect the CE-80 SPAN LINE XMIT jack through the 100Ω, 24 dB test pad to the PCM SIG IN jack. The PCM Detector LEDs should show PULSES (ON), OSC (OFF), ALL 1's (OFF), and ERROR (OFF).

3. Change the FAULT LINE RECEIVER/PCM GENERATOR switch to W/BPV. The ERROR LED should start flashing ON and OFF as bipolar violations are detected by the unit.

4. Change the BPV/LOGIC switch to LOGIC. The ERROR LED should stop flashing and remain OFF, while PULSES LED is ON, and OSC and ALL 1's LEDs remain OFF.

5. Set the FAULT LINE RECEIVER/PCM GENERATOR switch to W/ERRORS.

The ERROR LED should flash ON and OFF as logic errors are detected. The PULSES LED should remain ON, and OSC and ALL 1's LED's stay OFF.

6. Switch the BPV/LOGIC switch to the BPV position and note that the ERROR LED turns OFF, while PULSES stays ON and OSC and ALL 1's remain OFF.

7. Change the FAULT LINE RECEIVER/PCM GENERATOR switch to ALL 1's. The PULSES LED should be ON, and the ERROR LED turned OFF. In the CE-80A, the OSC OR ALL 1's LED should be ON, while in the CE-80B the OSC LED will be turned OFF and ALL 1's ON.

8. Place both SYSTEM switches to the T1C position. Turn the FAULT LINE RECEIVER/PCM GENERATOR switch back to QRSS and repeat Steps 2. through 7.

9. Place both SYSTEM switches to the T148 position. Turn the FAULT LINE RECEIVER/PCM GENERATOR switch back to QRSS and repeat Steps 2. through 7. In Step 7. the OSC and ALL 1's LED's will be OFF.

10. Place both SYSTEM switches to the DBNRY position. Turn the FAULT LINE RECEIVER/PCM GENERATOR switch back to QRSS and repeat Steps 2. through 7. In Step 7, the OSC LED will be OFF, and the ALL 1's OFF.

11. Return both SYSTEM switches to the T1 position. Turn the FAULT LINE RECEIVER/PCM GENERATOR switch to W/BPV. Change the ALARM switch to ON and verify that there are intermittent audible beeps.

12. Change the FAULT LINE RECEIVER/PCM GENERATOR switch to W/ERRORS, and place the BPV/LOGIC switch to the LOGIC position. Intermittent audible beeps should be heard.

13. Remove the connection to PCM SIG IN. The alarm should give a constant audible tone. Turn the ALARM switch to OFF.

14. Connect the rear panel BPV DETECTOR OUT jack to an oscilloscope, and change the CE-80 FAULT LINE RECEIVER/PCM GENERATOR switch to W/BPV. Intermittent pulses of approximately +5V should be observed on the oscilloscope.

TROUBLESHOOTING

3.18 The troubleshooting procedures for CE-80 circuits are presented in a flow diagram form showing a logical process of troubleshooting fo problems which might be encountered in normal ope ation. The troubleshooting diagram does not show, and is not intended to show, all problems which migh occur or all available solutions. It is a guide to be used to isolate problems to a printed circuit board b a logical process of elimination. When the failed board is located, it can be exchanged for a working board under Cushman Electronics' PC board exchang program. This will reduce instrument down-time du to failures to a minimum.

3.19 Test equipment required for the troubleshooting procedure is the same as that needed for checking instrument performance, and is listed in the paragraphs describing these procedures.

SERVICE OR REPAIR

3.20 In the event that factory service or repair seems to be required, contact the Cushman Electronics Customer Service Department for further service information or to make arrangements for return of the equipment to the factory or for shipment to one of the regional Service Centers. The factory address is:

Cushman Electronics, Inc.
Customer Service Department
2450 North First Street,
San Jose, California 95131
Telephone: (408) 263-8100

3.21 Cushman Electronics authorizes warranty and other service may be performed by the regional Service Centers. It is to your advantage to use the Service Center nearest you in order to speed the return of your equipment and to lessen your shipping costs, when applicable.

3.22 You must contact either the factory or the regional Service Center nearest you before shipping any equipment for repair. Service of your equipment will be scheduled at that time and you will be advised of the best method of shipment and other information.

3.23 For the address and telephone number of the regional Service Center nearest you, contact the Cushman Electronics factory Customer Service Department listed above.

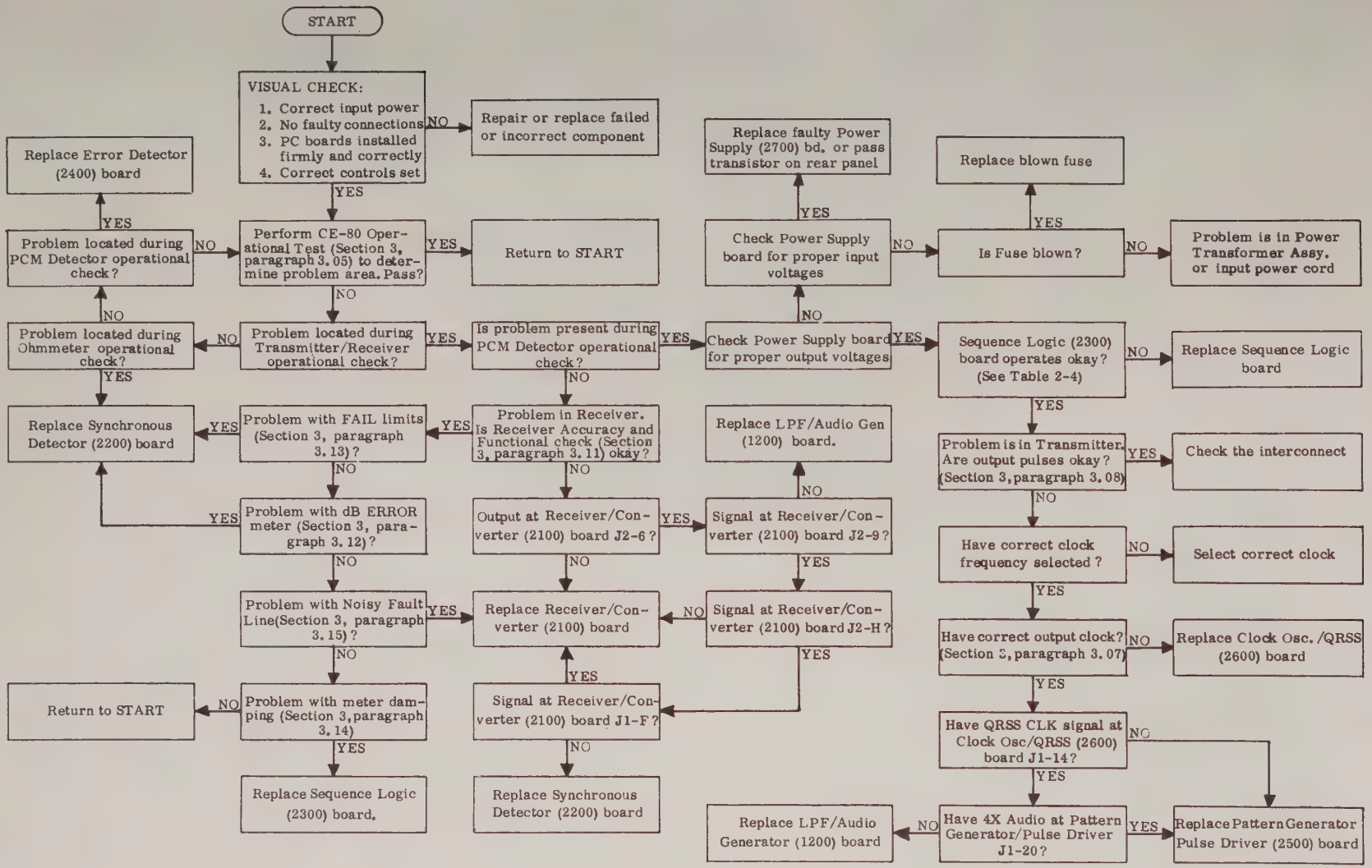


Figure 3-7. CE-80A/CE-80B Troubleshooting Chart

PREPARATION FOR SHIPMENT

3.24 It is recommended that the shipping box and foam packaging be kept in case it becomes necessary to ship the instrument to the service point or factory for service or repair. Contact the Cushman Electronics Customer Service Department before returning an instrument. The following is a general guide for repackaging the instrument for shipment.

NOTE

If the instrument is to be shipped, attach a tag to the instrument identifying the owner and indicate the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, always identify the instrument by model number and serial number.

3.25 If the original container is to be used, proceed as follows:

a. Place the instrument in the original container. If the original container is not available, one can be purchased from Cushman Electronics.

b. Make sure that the container is well sealed with strong tape.

3.26 If the original container is not used, proce as follows:

a. Wrap the instrument in plastic or heavy paper before placing in an inn container.

b. Place packing material around all si of the instrument.

c. Place the instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal ban

d. Mark the shipping container: "DELICATE ELECTRONIC INSTRUMENT" "FRAGILE".

SECTION 4
PARTS LISTS AND SCHEMATIC DIAGRAMS

Parts Lists and Schematic Diagrams

4.01 The following parts lists and schematic diagrams have been arranged in order according to the Circuit Reference Series numbers. Refer to paragraph 2.02. Each schematic diagram and parts list is identified with this number. The circuit boards in the instrument are marked with an identifying Assembly Number. See the Printed Circuit Board and Circuit Reference Numbers Cross Reference Table 4-1 below.

4.02 Parts list pages are grouped with the schematic diagrams to which they refer. Component identification drawings showing the location of the individual components on the circuit board are placed on the inner sheet of the schematic diagram to which they apply.

Table 4-1. Printed Circuit Board and Circuit Reference Numbers Cross Reference

Ckt. Bd. No.	CIRCUIT TITLE	Ckt. Ref. No.	Assembly No.	Fig. No.	Page No.
	Front Panel (CE-80A)	1000	7003-0133	4-1	4-3
	Front Panel (CE-80B)	1000	7003-0145	4-2	4-7
1780-0900	Display	1100	7001-0527	4-3	4-11
1780-0903	LPF/Audio Generator	1200	7001-0526	4-4	4-15
1780-0909	Main Interconnect (CE-80A)	2000	7001-0528	4-5	4-19
1780-0914	Main Interconnect (CE-80B)	2000	7001-0608	4-6	4-23
1780-0906	Receiver/Converter	2100	7001-0525	4-7	4-31
1780-0905	Synchronous Detector	2200	7001-0524	4-8	4-39
1780-0908	Sequence Logic	2300	7001-0523	4-9	4-43
1780-0913	Error Detector (CE-80A)	2400	7001-0603	4-10	4-51
1780-0913	Error Detector (CE-80B)	2400	7001-0605	4-11	4-57
1780-0901	Pattern Generator/Pulse Driver	2500	7001-0530	4-12	4-61
1780-0904	Clock Oscillator/QRSS (CE-80A)	2600	7001-0529	4-13	4-67
1780-0904	Clock Oscillator/QRSS (CE-80B)	2600	7001-0520	4-14	4-73
1780-0907	Power Supply (CE-80A)	2700	7001-0519	4-15	4-77
1780-0912	Power Supply (CE-80B)	2700	7001-0607	4-16	4-83
	Rear Panel	3000	7003-0134	4-17	4-87

PANEL, FRONT. 1000 (CE-80)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
1000	Front Panel	7003-0133	Cushman	
	DIODES			
CR1	Light Emitting Diode, Yellow, W angle	1281-0138	HP	5082-4550
CR2	Light Emitting Diode, Green, W angle	1281-0139	HP	5082-4950
CR3	Light Emitting Diode, Red, W angle	1281-0143	HP	5082-4850
CR4	Light Emitting Diode, Red, W angle	1281-0143	HP	5082-4850
	LIGHT FILTERS			
	Filter, Readout, Red, non-refl	4941-0025	Cushman	
	JACKS			
J1	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
J2	Jk, Phone, Mintr, 3 cond, dbl closed	2586-0029	Switchcraft	UJ-4B
J3	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
J4	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
J5	Jk, Phone, Mintr, 3 cond, dbl closed	2586-0029	Switchcraft	UJ-4B
J6	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
J7	Jk, Phone, Mintr, 3 cond, dbl closed	2586-0029	Switchcraft	UJ-4B
J8	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
	KNOBS			
	Knob, Lever switch	2780-0021	Oak Indust	3-4464-201 Black
	Knob, Bar	2780-0028	Cushman	
	METERS			
M1	Meter, DC, 500-0-500 μA	1402-0037	Cushman	
	PCB ASSEMBLIES			
1200	PCB Assy, LPF/Audio Gen	7001-0526	Cushman	
1100	PCB Assy, Display	7001-0527	Cushman	
	RESISTORS			
R1	MF, 100Ω, ±1%, 150 PPM	1074-1033	Dale	MF 1/8 T1
	SWITCHES			
S1	Sw, Toggle, DPDT, Flat Handle	1850-0022	C & K	7201P3N
S2	Sw, Toggle, 3PDT, Flat Handle	1850-0029	C & K	7305P3DZQ
S3	Sw, Pushbutton, SPDT Min, MOM	1852-0035	C & K	8125W
S4	Sw, Pushbutton, SPDT Min, MOM	1852-0035	C & K	8125W
S5	Sw, Lever, 3 pole, 4 pos	1851-0126	Cushman	
S6	Sw, Toggle, DPDT, Flat Handle	1850-0022	C & K	7201P3N
S7	Sw, Lever, 3 pole, 4 pos	1851-0126	Cushman	
S8	Sw, Toggle, DPDT, Flat Handle	1850-0022	C & K	7201P3N

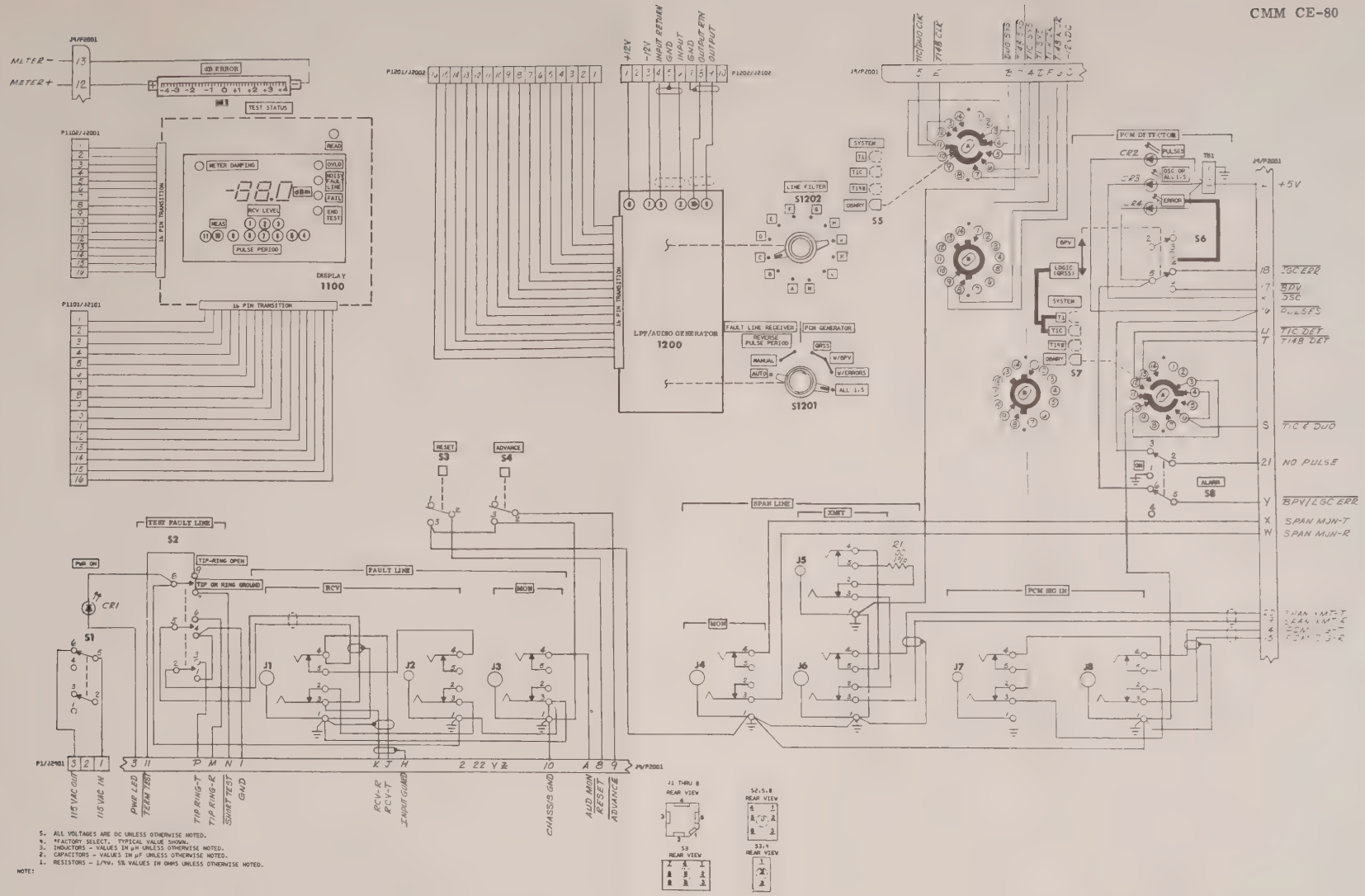
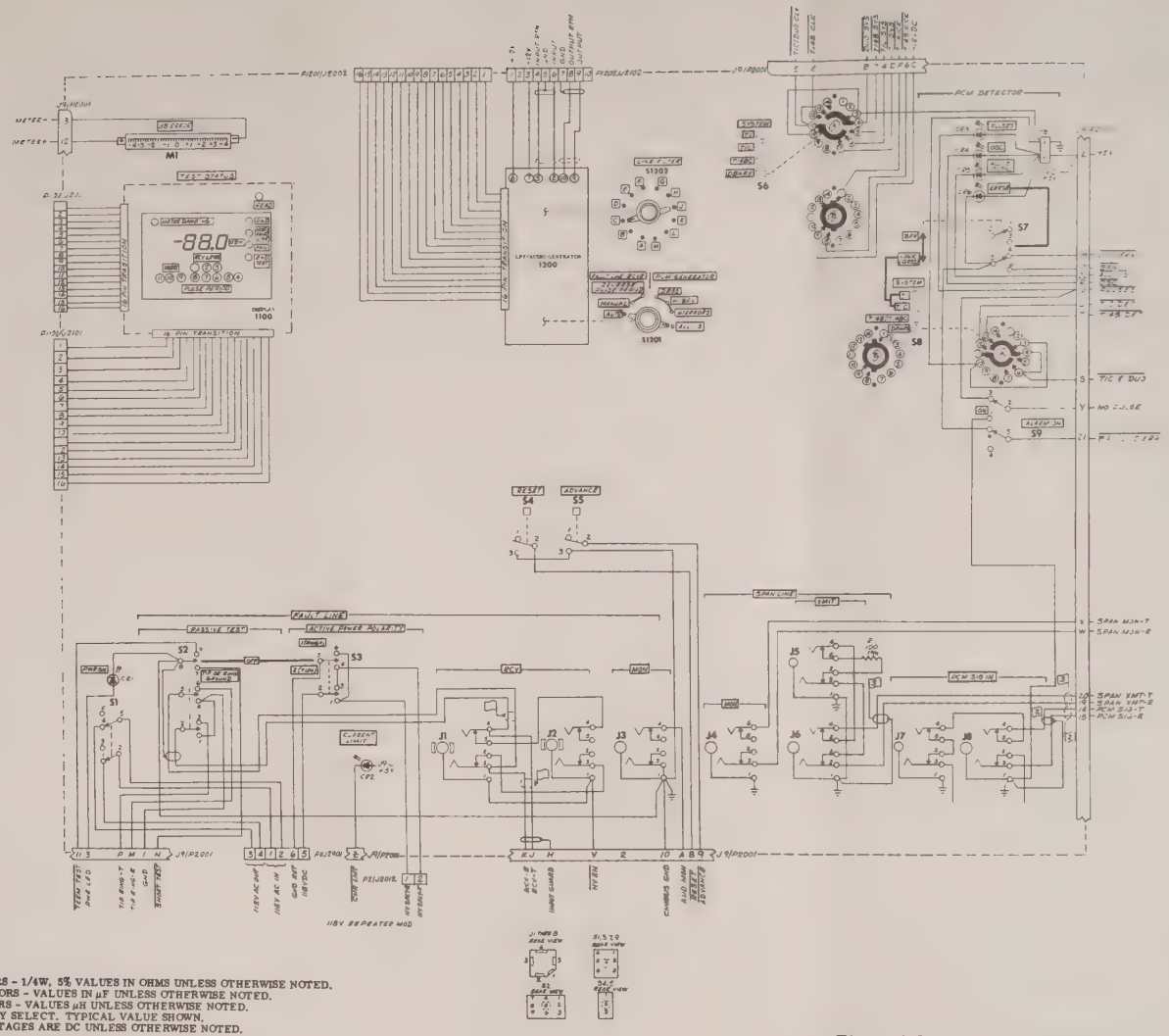


Figure 4-1. Front Panel (CE-80A), 1000

PANEL, FRONT. 1000 (CE080B)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
1000	Front Panel	2800-0271	Cushman	
	DIODES			
CR1	Light Emitting Diode, Yellow, W angle	1281-0138	HP	5082-4550
CR2	Light Emitting Diode, Red, W angle	1281-0143	HP	5082-4850
CR3	Light Emitting Diode, Green, W angle	1281-0139	HP	5082-4950
CR4	Light Emitting Diode, Red, W angle	1281-0143	HP	5082-4850
CR5	Light Emitting Diode, Red, W angle	1281-0143	HP	5082-4850
CR6	Light Emitting Diode, Red, W angle	1281-0143	HP	5082-4850
	LIGHT FILTERS			
	Filter, Readout, Red, non-refl	4941-0025	Cushman	
	JACKS			
J1	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
J2	Jk, Phone, Mintr, 3 cond, dbl closed	2586-0029	Switchcraft	UJ-4B
J3	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
J4	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
J5	Jk, Phone, Min, 3 cond, dbl closed	2586-0029	Switchcraft	UJ-4B
J6	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
J7	Jk, Phone, Min, 3 cond, dbl closed	2586-0029	Switchcraft	UJ-4B
J8	Jk, Phone, 3 cond, dbl closed ckt	2586-0028	Switchcraft	M-114B
	KNOBS			
	Knob, Lever switch	2780-0021	Oak Indust	3-4464-201 Black
	Knob, Bar	2780-0028	Cushman	
	METERS			
M1	Meter, DC, 500-0-500 μA	1402-0037	Cushman	
	PCB ASSEMBLIES			
1200	PCB Assy, LPF/Audio Gen	7001-0526	Cushman	
1100	PCB Assy, Display	7001-0527	Cushman	
	RESISTORS			
R1	MF, 100Ω, ±1%, 150 PPM	1074-1033	Dale	MF 1/8 T1
	SWITCHES			
S1	Sw, Toggle, DPDT, Flat Handle	1850-0022	C & K	7201P3N
S2	Sw, Toggle, 3PDT, Flat Handle	1850-0029	C & K	7305P3DZQ
S3	Sw, Toggle, DPDT, Lkg Lever	1850-0035	C & K	7203K
S4	Sw, Pushbutton, SPDT Min, MOM	1852-0035	C & K	8125W
S5	Sw, Pushbutton, SPDT Min, MOM	1852-0035	C & K	8125W
S6	Sw, Lever, 3 pole, 4 pos	1851-0126	Cushman	
S7	Sw, Toggle, DPDT, Flat Handle	1850-0022	C & K	7201P3N
S8	Sw, Lever, 3 pole, 4 pos	1851-0126	Cushman	
S9	Sw, Toggle, DPDT, Flat Handle	1850-0022	C & K	7201P3N

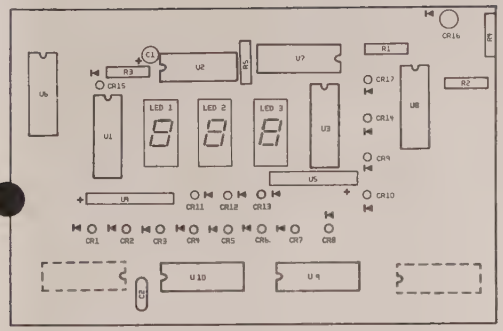


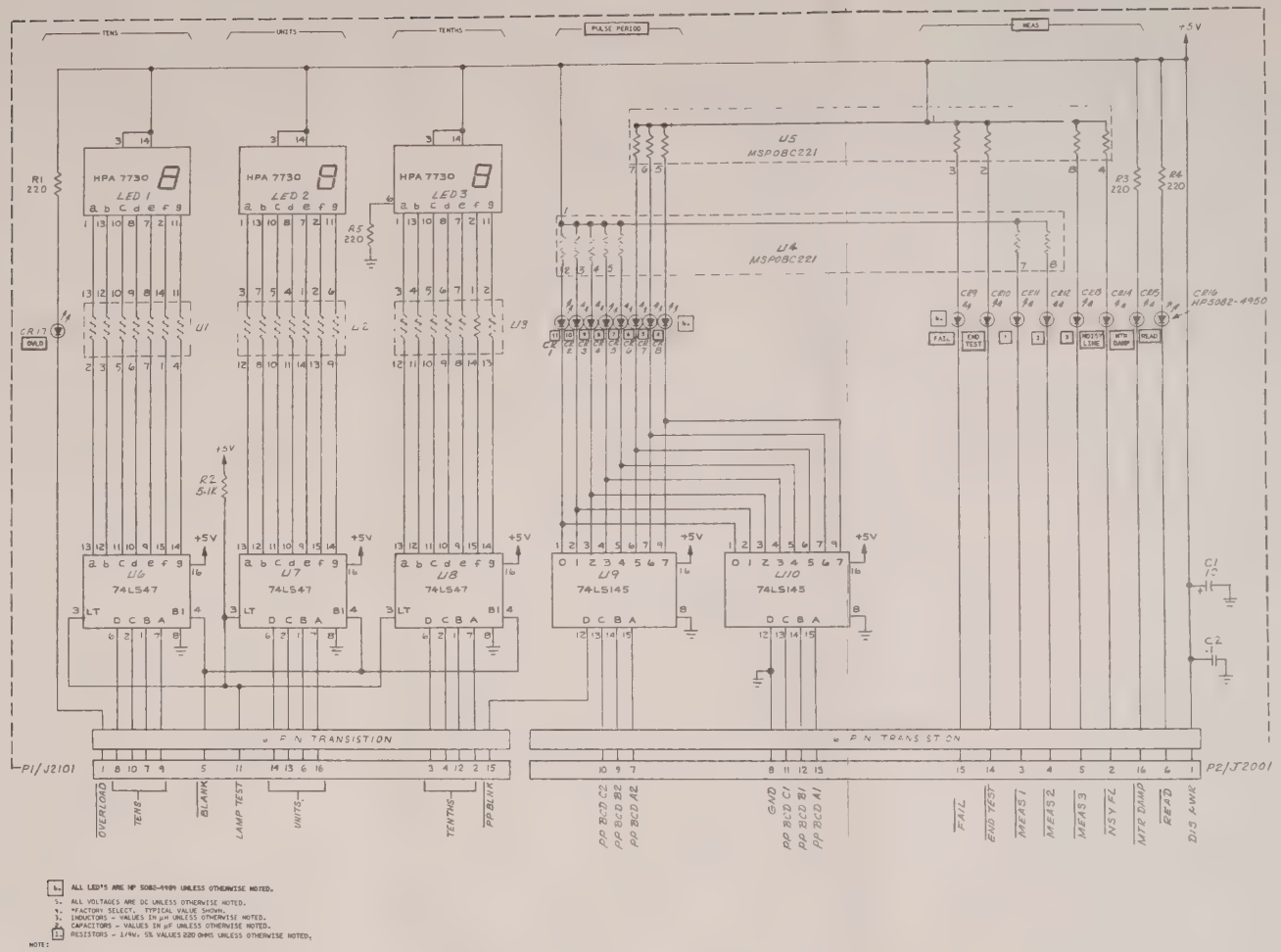
NOTE:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 4-2. Front Panel (CE-80B), 1000

DISPLAY, 1000

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
1100	Display	7001-0527	Cushman	
	PCB Assy	1780-0900	Cushman	
	CAPACITORS			
C1	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C2	Min Cer, .1μF, 20%, 50V	1005-0097	Erie	8121-050-651-104M
	DIODES			
CR1	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR2	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR3	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR4	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR5	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR6	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR7	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR8	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR9	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR10	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR11	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR12	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR13	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR14	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR15	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR16	Lt Emit, Grn, W Ang	1281-0139	HP	5082-4950
CR17	Lt Emit, Red, W Ang	1281-0137	HP	5082-4484
CR18	Alpha-Num, Seg Rdout	1281-0081	HP	5082-7730
CR19	Alpha-Num, Seg Rdout	1281-0081	HP	5082-7730
CR20	Alpha-Num, Seg Rdout	1281-0081	HP	5082-7730
	RESISTORS			
R1	Comp, 220 Ohm, 5%, 1/4W	1066-2215	Allen Bradley	CB2215
R2	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R3	Comp, 220 Ohm, 5%, 1/4W	1066-2215	Allen Bradley	CB2215
R4	Comp, 220 Ohm, 5%, 1/4W	1066-2215	Allen Bradley	CB2215
R5	Comp, 220 Ohm, 5%, 1/4W	1066-2215	Allen Bradley	CB2215
	INTEGRATED CIRCUITS			
U1	Rnet, 7/220 Ohm, 2%, 250 PPM	1115-0001	Dale	LDP 1401221G
U2	Rnet, 7/220 Ohm, 2%, 250 PPM	1115-0001	Dale	LDP 1401221G
U3	Rnet, 7/220 Ohm, 2%, 250 PPM	1115-0001	Dale	LDP 1401221G
U4	Rnet, 7/220 Ohm, 2%, 100 PPM	1115-0002	Dale	MSP08C01-221G
U5	Rnet, 7/220 Ohm, 2%, 100 PPM	1115-0002	Dale	MSP08C01-221G
U6	74LS47, BCD, 7 Seg, Dcdr/Drvr	2025-0218	National	DM74LS47N
U7	74LS47, BCD, 7 Seg, Dcdr/Drvr	2025-0218	National	DM74LS47N
U8	74LS47, BCD, 7 Seg, Dcdr/Drvr	2025-0218	National	DM74LS47N
U9	74LS145, BCD-To-DEC Dcdr	2025-0222	TI	SN74LS145N
U10	74LS145, BCD-To-DEC Dcdr	2025-0222	TI	SN74LS145N





NOTE:
1. ALL LED'S ARE HP 5082-4901 UNLESS OTHERWISE NOTED.
2. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
3. *FACTORY SELECT. TYPICAL VALUE SHOWN.
4. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
5. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
6. RESISTORS - 1/4W, 5% VALUES 220 OHMS UNLESS OTHERWISE NOTED.

Figure 4-3. Display, 1100

LPF/AUDIO GENERATOR, 1200

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
1200	LPF/ Audio Generator	7001-0526	Cushman	
	PC Board Assy	1780-0903	Cushman	
	CAPACITORS			
C1	Polyprop, .01μF, 1%, 100V	1008-0105	Stettner Trush	KP1830-310/01-1%
C2	Polyprop, .01μF, 1%, 100V	1008-0105	Stettner Trush	KP1830-310/01-1%
C3	Polyprop, .01μF, 1%, 100V	1008-0105	Stettner Trush	KP1830-310/01-1%
C4	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C5	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C6	Mica, 2700 pF, 5%, 500V	1002-0081	Elmenco	DM19-C-272J
C7	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C8	Polyprop, .01μF, 1%, 100V	1008-0105	Stettner Trush	KP1830-310/01-1%
	TRANSISTORS			
Q1	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
	RESISTORS			
R1	MF, 20.5K, 1%, 100 PPM	1075-0185	Shelly Rod	RN55D
R2	MF, 68.1K, 1%, 100 PPM	1075-0136	Dale	MFF 1/8 T1
R3	MF, 33.2K, 1%, 100 PPM	1075-0098	Dale	MFF 1/8 T1
R4	MF, 17.8K, 1%, 150 PPM	1074-1021	Dale	MFF 1/8 T1
R5	MF, 12.7K, 1%, 150 PPM	1074-1035	Dale	MFF 1/8 T1
R6	MF, 9.09K, 1%, 100 PPM	1074-1019	Dale	MFF 1/8 T1
R7	MF, 20.5K, 1%, 100 PPM	1075-0185	Shelly Rod	RN55D
R8	MF, 68.1K, 1%, 100 PPM	1075-0136	Dale	MFF 1/8 T1
R9	MF, 33.2K, 1%, 100 PPM	1075-0098	Dale	MFF 1/8 T1
R10	MF, 17.8K, 1%, 150 PPM	1074-1021	Dale	MFF 1/8 T1
R11	MF, 12.7K, 1%, 150 PPM	1074-1035	Dale	MFF 1/8 T1
R12	MF, 9.09K, 1%, 100 PPM	1074-1019	Dale	MFF 1/8 T1
R13	MF, 14K 1%, 100 PPM	1075-0016	Dale	MFF 1/8 T1
R14	MF, 47.5K, 1%, 100 PPM	1075-0076	Dale	MFF 1/8 T1
R15	MF, 22.6K, 1%, 100 PPM	1074-1056	Dale	MFF 1/8 T1
R16	MF, 12.1K, 1%, 100 PPM	1075-0011	Dale	MFF 1/8 T1
R17	MF, 8.66K, 1%, 100 PPM	1075-0184	Shelly Rod	RN55D
R18	MF, 6.19K, 1%, 100 PPM	1075-0109	Dale	MFF 1/8 T1
R19	MF, 14K, 1%, 100 PPM	1075-0016	Dale	MFF 1/8 T1
R20	MF, 47.5K, 1%, 100 PPM	1075-0076	Dale	MFF 1/8 T1
R21	MF, 22.6K, 1%, 100 PPM	1074-1056	Dale	MFF 1/8 T1
R22	MF, 12.1K, 1%, 100 PPM	1075-0011	Dale	MFF 1/8 T1
R23	MF, 8.66K, 1%, 100 PPM	1075-0184	Shelly Rod	RN55D
R24	MF, 6.19K, 1%, 100 PPM	1075-0109	Dale	MFF 1/8 T1
R25	MF, 182K, 1%, 100 PPM	1075-0147	Dale	MFF 1/8 T1
R26	MF, 143K, 1%, 100 PPM	1075-0050	Dale	MFF 1/8 T1
R27	MF, 100K, 1%, 100 PPM	1075-0105	Dale	MFF 1/8 T1
R28	MF, 93.1K, 1%, 100 PPM	1075-0029	Dale	MFF 1/8 T1
R29	MF, 82.5K, 1%, 100 PPM	1075-0064	Dale	MFF 1/8 T1
R30	MF, 66.5K, 1%, 100 PPM	1075-0143	Dale	MFF 1/8 T1
R31	MF, 53.6K, 1%, 150 PPM	1074-1023	Dale	MFF 1/8 T1
R32	MF, 47.5K, 1%, 100 PPM	1075-0076	Dale	MFF 1/8 T1
R33	MF, 43.2K, 1%, 100 PPM	1075-0117	Dale	MFF 1/8 T1
R34	MF, 20.5K, 1%, 100 PPM	1075-0185	Shelly Rod	RN55D
R35	MF, 33.2K, 1%, 100 PPM	1075-0098	Dale	MFF 1/8 T1

LPF/AUDIO GENERATOR, 1200 (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R36	MF, 226K, 1%, 100 PPM	1075-0195	Dale	MF 1/10 T9
R37	MF, 301 Ohm, 1%, 100 PPM	1075-0048	Dale	MFF 1/8 T1
R38	MF, 3.83K, 1%, 100 PPM	1075-0052	Dale	MFF 1/8 T1
R39	MF, 16.5K, 1%, 100 PPM	1075-0058	Dale	MFF 1/8 T1
R40	MF, 6.19K, 1%, 100 PPM	1075-0109	Dale	MFF 1/8 T1
R41	MF, 1.07K, 1%, 100 PPM	1075-0166	Dale	MFF 1/8 T1
R42	MF, 2.94K, 1%, 100 PPM	1075-0108	Dale	MFF 1/8 T1
R43	MF, 2.94K, 1%, 100 PPM	1075-0108	Dale	MFF 1/8 T1
R44	MF, 2.94K, 1%, 100 PPM	1075-0108	Dale	MFF 1/8 T1
R45	MF, 1.43K, 1%, 100 PPM	1075-0021	Dale	MFF 1/8 T1
R46	MF, 18.7K, 1%, 150 PPM	1074-1022	Dale	MFF 1/8 T1
R47	MF, 619 Ohm, 1%, 100 PPM	1075-0063	Dale	MFF 1/8 T1
R48	Comp, 2.7K, 5%, 1/4W	1066-2725	Allen Bradley	CB2725
R49	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R50	MF, 30.9K, 1%, 100 PPM	1075-0186	Shelly Rod	RN55D
R51	MF, 226K, 1%, 100 PPM	1075-0195	Dale	MF 1/10 T9
R52	MF, 7.68K, 1%, 100 PPM	1075-0054	Dale	MFF 1/8 T1
R53	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R54	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R55	MF, 100K, 1%, 100 PPM	1075-0105	Dale	MFF 1/8 T1
R56	MF, 53.6K, 1%, 150 PPM	1074-1023	Dale	MFF 1/8 T1
R57	MF, 110K, 1%, 100 PPM	1075-0162	Dale	MFF 1/8 T1
R58	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R59	Pot, 20K, 10%, 3/4W, 15T, Cermet	1215-0021	Beckman	89WR
R60	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R61	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R62	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
	SWITCHES			
S1	Rtry, 6 Po 12 Posn, PCB MT	1851-0118	Cushman	
S2	Rtry, 2 Pole, 7 Posn, PCB MT	1851-0117	Cushman	
	INTEGRATED CIRCUITS			
U1	Op Ampl	2025-0161	RCA	CA3130T
U2	Dual, Op Ampl	2025-0213	Motorola	MC4558CP

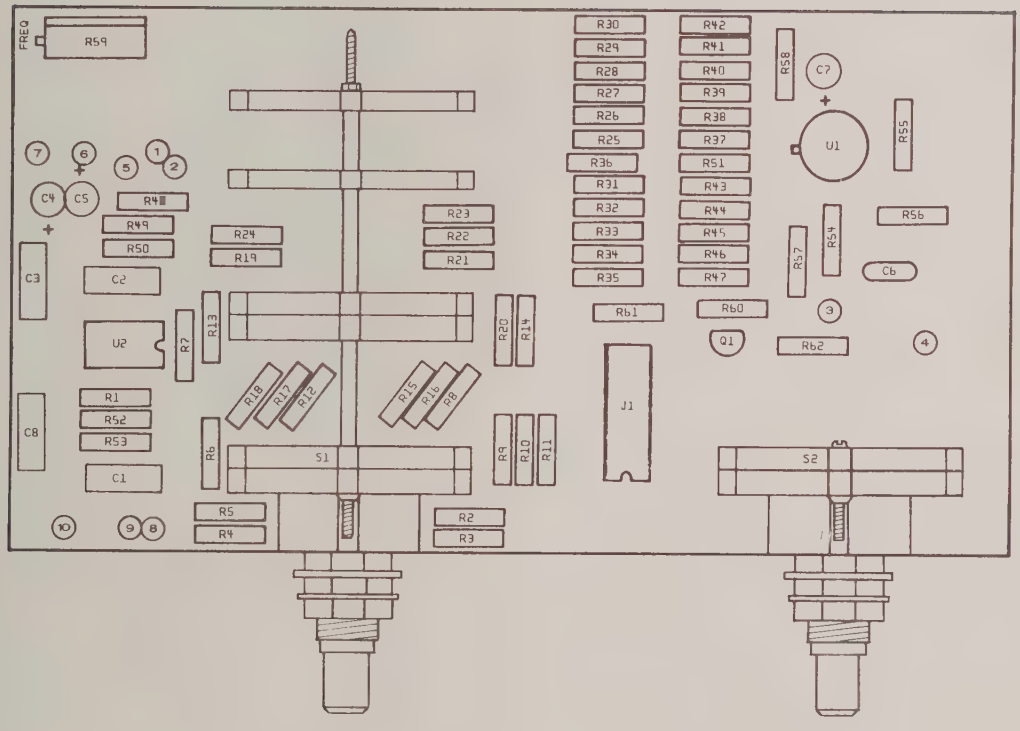
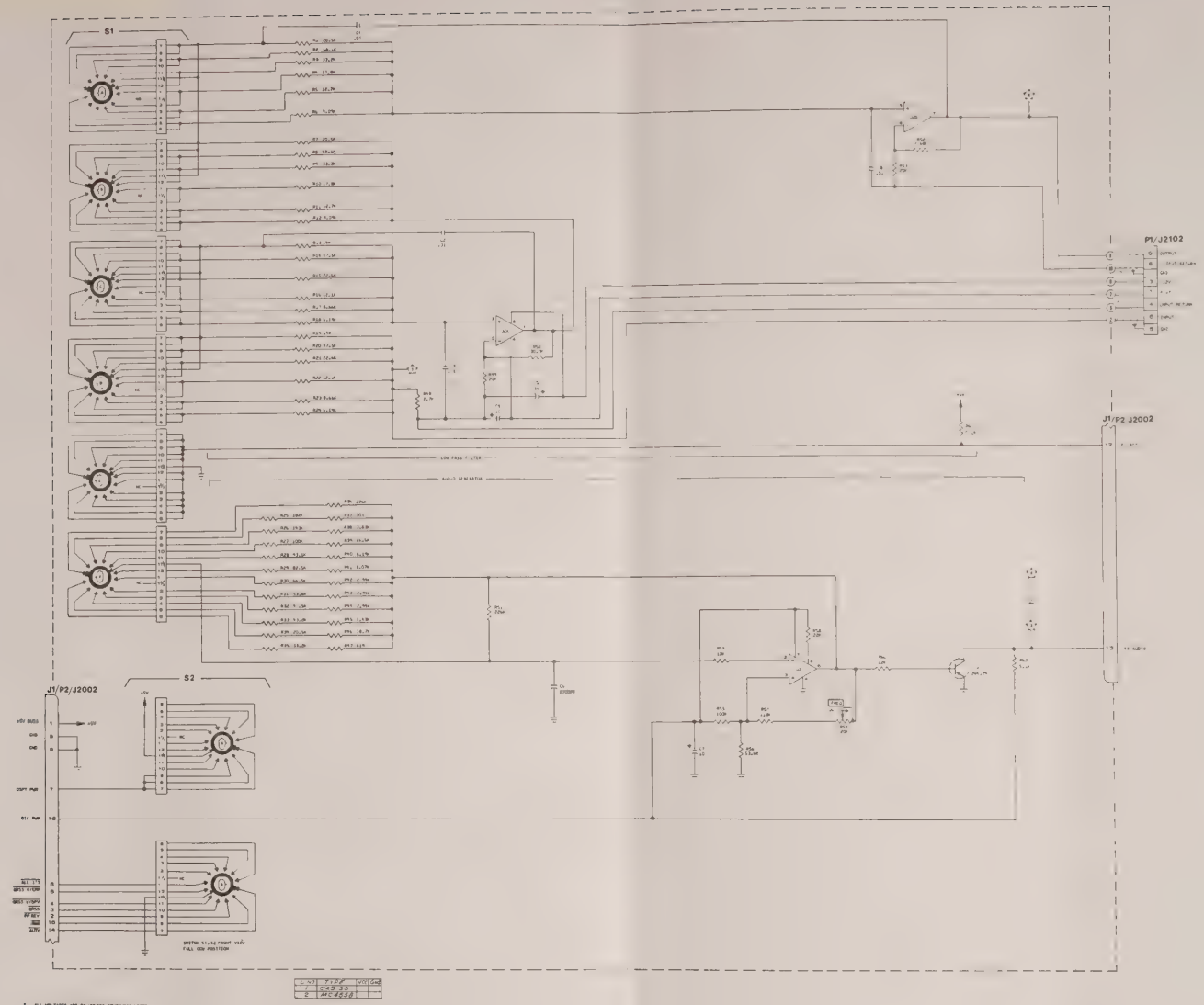


Figure 4-4. LPF/Audio Generator Assembly. 1200



NOTE:
1. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
2. *FACTORY SELECT - TYPICAL VALUE SHOWN.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
5. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.

CKT NO	TYPE	POLAR
1	CA3130	
2	MC4558	

Figure 4-4. LPF/Audio Generator. 1200

MAIN INTERCONNECT. 2000 (CE-80A)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2000	Main Interconnect	7001-0528	Cushman	
	PC Board Assy	1780-0909	Cushman	
	CONNECTORS			
J1	Socket, 16 Pin, IC	2606-0006	Cinch	133-51-02-006
J2	Socket, 16 Pin, IC	2606-0006	Cinch	133-51-02-006
J3	44 Cont, Dip Term, PCB Jack	2535-0076	Continental	K600-11-44Y19A
J4	44 Cont, Dip Term, PCB Jack	2535-0076	Continental	K600-11-44Y19A
J5	72 Cont, Dip Term, PCB Jack	2535-0094	Viking	2VK36D/2-12
J6	44 Cont, Dip Term, PCB Jack	2535-0076	Continental	K600-11-44Y19A
J7	44 Cont, Dip Term, PCB Jack	2535-0076	Continental	K600-11-44Y19A
J8	44 Cont, Dip Term, PCB Jack	2535-0076	Continental	K600-11-44Y19A
J9	44 Cont, Dip Term, PCB Jack	2535-0076	Continental	K600-11-44Y19A
J10	2 Pin Locking Mintr Jack	2535-0086	Molex	09-65-1021
J11	8 pin Locking Mintr Jack	2535-0103	Molex	09-65-1081
	RESISTORS			
R1	Comp, 150Ω, ±5%, 1/4W	1066-1515	Allen Bradley	CB1515
R1	Comp, 150Ω, ±5%, 1/4W	1066-1515	Allen Bradley	CB1515

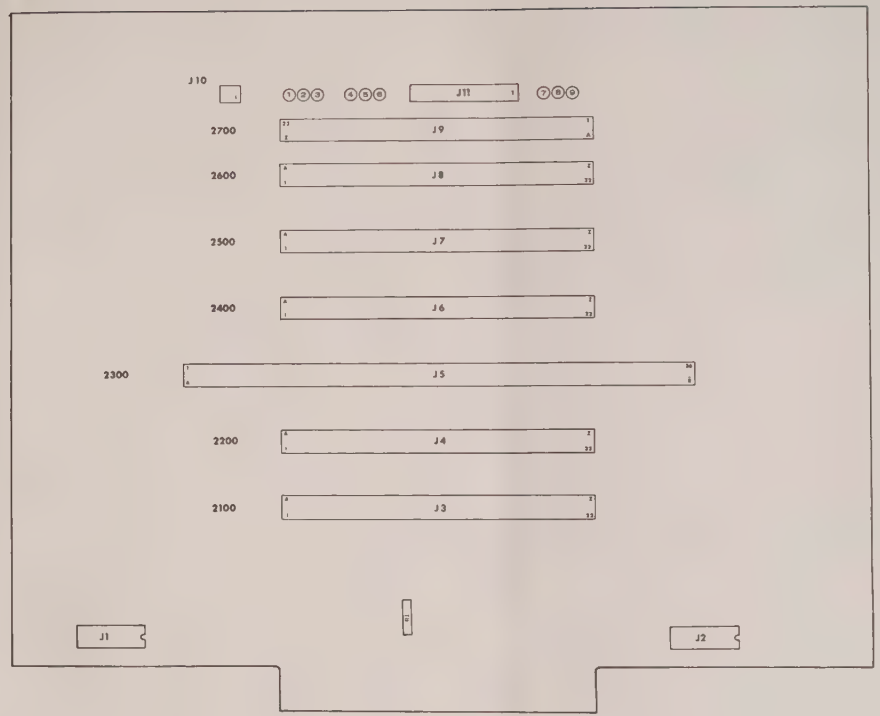
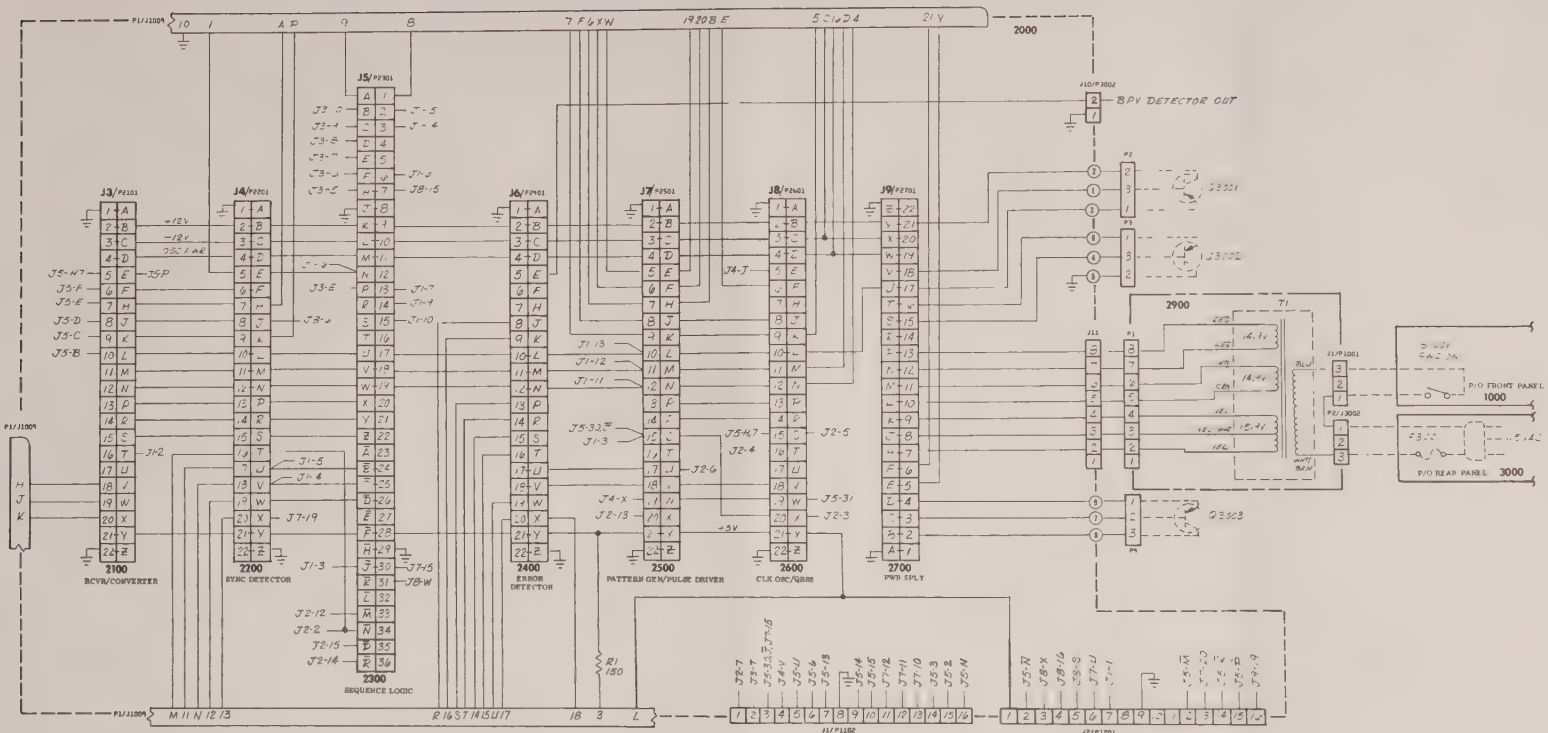


Figure 4-5. Main Interconnect Assembly. (CE-80A). 2000.



NOTES:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 4-5. Main Interconnect (CE-80A), 2000

MAIN INTERCONNECT. 2000 (CE-80B)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2000	Main Interconnect	7001-0608	Cushman	
	PC Board Assy	1780-0914	Cushman	
	CAPACITORS			
J 1	Skt, 16 pin dual in-line	2606-0006	Cinch	133-51-02-006
J 2	Skt, 16 pin dual in-line	2606-0006	Cinch	133-51-02-006
J 3	Conn, 44 cont dbl row PCB Jk	2535-0076	Continental Conn	K600-11-44Y19A
J 4	Conn, 44 cont dbl row PCB Jk	2535-0076	Continental Conn	K600-11-44Y19A
J 5	Conn, 72 cont dbl row PCB Jk	2535-0094	Viking	2VK36D/2-12
J 6	Conn, 44 cont dbl row PCB Jk	2535-0076	Continental Conn	K600-11-44Y19A
J 7	Conn, 44 cont dbl row PCB Jk	2535-0076	Continental Conn	K600-11-44Y19A
J 8	Conn, 44 cont dbl row PCB Jk	2535-0076	Continental Conn	K600-11-44Y19A
J 9	Conn, 44 cont dbl row PCB Jk	2535-0076	Continental Conn	K600-11-44Y19A
J 10	Conn, 2 pin locking Mintr Jk	2535-0086	Molex	09-65-1021
J 11	Conn, 10 pin locking PCB Mt.	2535-0161	Molex	09-65-1101
J 12	Conn, 2 pin locking Mintr Jk	2535-0086	Molex	09-65-1021
	RESISTORS			
R1	Comp, 150Ω, ±5%, 1/4 W	1066-1515	Allen Bradley	CB1515

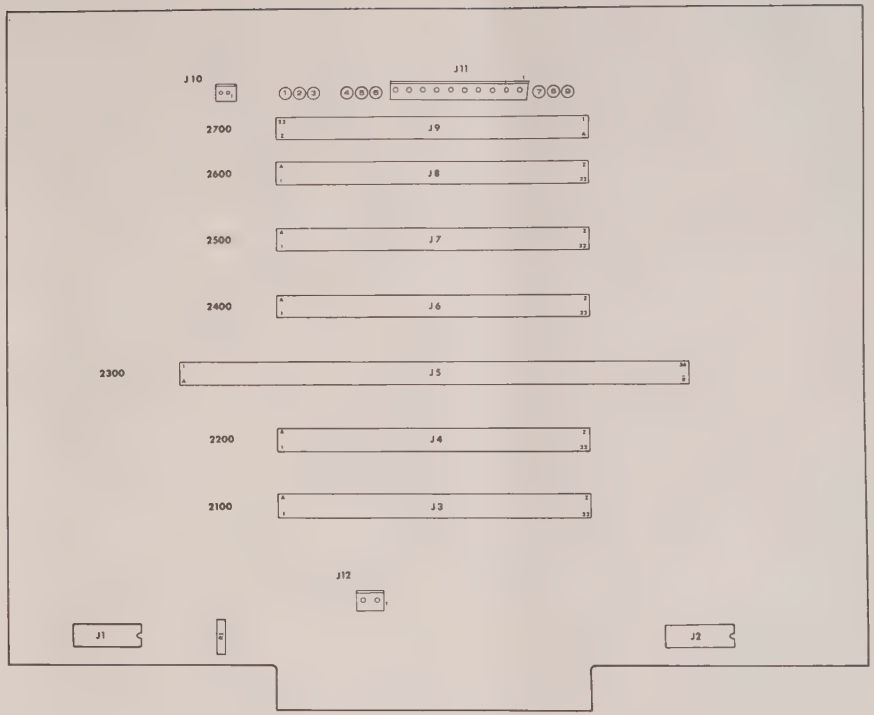
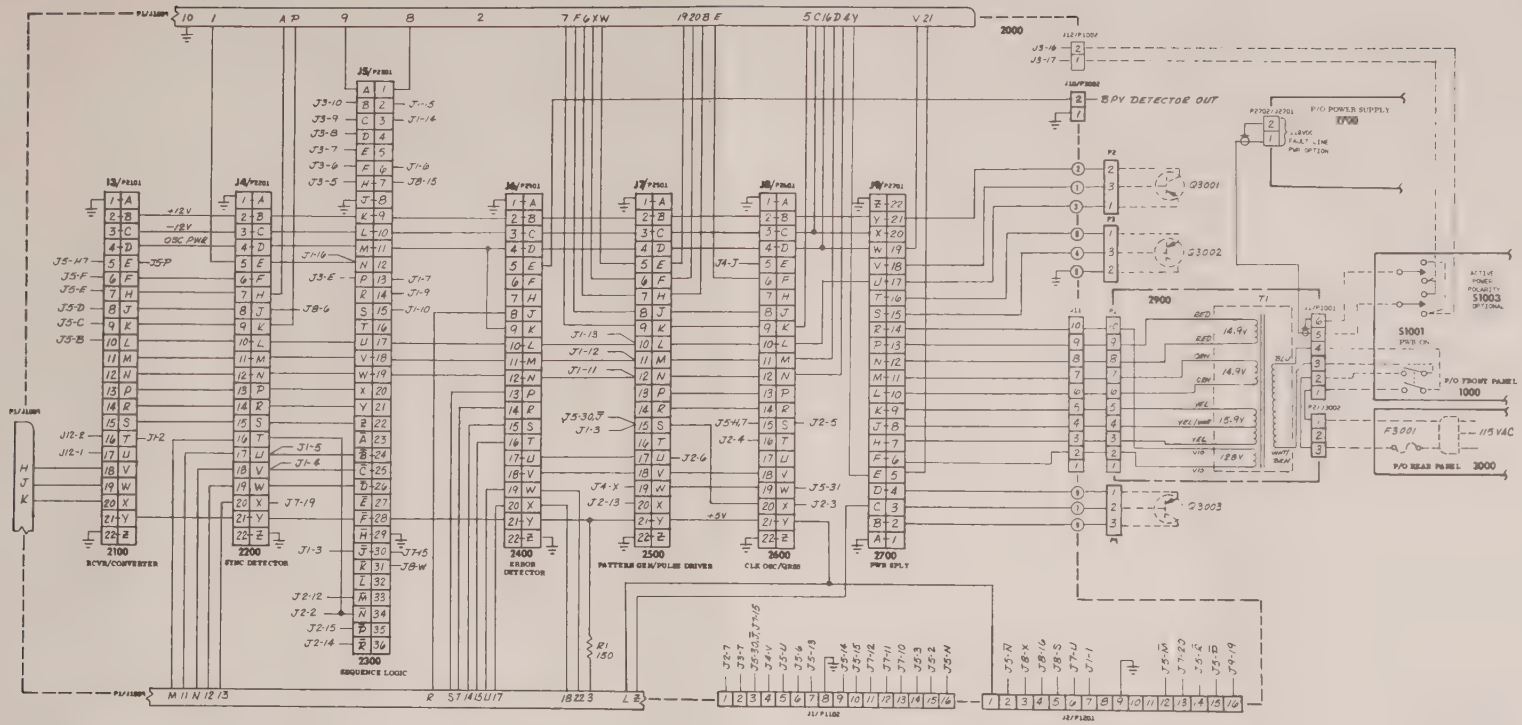


Figure 4-6. Main Interconnect Assembly. 2000 (CE-80B)



NOTE:
1. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
2. *FACTORY SELECT. TYPICAL VALUE SHOWN.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
5. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.

Figure 4-6. Main Interconnect (CE-80B). 2000

SYNCHRONOUS DETECTOR, 2200

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2200	Synchronous Detector	7001-0524	Cushman	
	PC Board	1780-0905	Cushman	
	CAPACITORS			
C1	Elect, 100 μF, +50-10%, 16V	1013-0033	Matsushita	ECE-A16V100L
C2	Elect, 100 μF, +50-10%, 16V	1013-0033	Matsushita	ECE-A16V100L
C3	Elect, 100 μF, +50-10%, 16V	1013-0033	Matsushita	ECE-A16V100L
C4	Elect, 100 μF, +50-10%, 16V	1013-0033	Matsushita	ECE-A16V100L
C5	Mica, 100 pF, 5%, 500V	1002-0011	Elmenco	DM15-F-101J
C6	Mica, 1000 pF, 5%, 500V	1002-0015	Elmenco	DM15-F-102J
C7	Mica, 1000 pF, 5%, 500V	1002-0015	Elmenco	DM15-F-102J
C8	Mica, 100 pF, 5%, 500V	1002-0011	Elmenco	DM15-F-101J
C9	Elect, 100 μF, +50-10%, 16V	1013-0033	Matsushita	ECE-A16V100L
C10	Polyest, .1 μF, 10%, 100V	1008-0098	Plessey	60C104K100
C11	Met-Mylar, .22 μF, 10%, 100V	1008-0091	Electrocube	232A1B224K
C12	Polyest, .01 μF, 10%, 600V	1008-0099	Plessey	60103K630
C13	Met-Mylar, 2 μF, 10%, 100V	1008-0063	Elpac	ZA-100V
C14	Elect, 100 μF, +50-10%, 16V	1013-0033	Matsushita	ECE-A16V100L
C15	Polyest, .0047 μF, 10%, 100V	1008-0053	Sprague	225P47291WD3
C16	Polyest, .0047 μF, 10%, 100V	1008-0053	Sprague	225P47291WD3
C17	Min cer, .1 μF, 20%, 50V	1005-0097	Erie	8121-050-651-104M
C18	Mica, 1000 pF, 5%, 500V	1002-0015	Elmenco	DM15-F-102J
C19	Polyest, .1 μF, 10%, 100V	1008-0098	Plessey	60C104K100
C20	Mica, 30 pF, 5%, 500V	1002-0043	Elmenco	DM15-E-300J
C21	Polycarb, 1 μF, 5%, 50V	1008-0081	Electrocube	625B1A105J
C22	Mica, 1000 pF, 5%, 500V	1002-0015	Elmenco	DM15-F-102J
C23	Polycarb, 1 μF, 5%, 50V	1008-0081	Electrocube	625B1A105J
C24	Mica, 1000 pF, 5%, 500V	1002-0015	Elmenco	DM15-F-102J
C25	Polycarb, 1 μF, 5%, 50V	1008-0081	Electrocube	625B1A105J
C26	Mica, 1000 pF, 5%, 500V	1002-0015	Elmenco	DM15-F-102J
C27	Polycarb, 1 μF, 5%, 50V	1008-0081	Electrocube	625B1A105J
C28	Polycarb, 1 μF, 5%, 50V	1008-0081	Electrocube	625B1A105J
C29	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C30	Mica, 220 pF, 5%, 500V	1002-0029	Elmenco	DM15-F-221J
C31	Mica, 220 pF, 5%, 500V	1002-0029	Elmenco	DM15-F-221J
C32	Min cer, .1 μF, 20%, 50V	1005-0097	Erie	8121-050-651-104M
C33	Polyest, .1 μF, 10%, 100V	1008-0098	Plessey	60C104K100
C34	Min cer, .1 μF, 20%, 50V	1005-0097	Erie	8121-050-651-104M
	DIODES			
CR1	Si, Zener, 3.6V, 5%	1281-0076	Fairchild	1N747A
CR2	Si, Zener, 3.6V, 5%	1281-0076	Fairchild	1N747A
CR3	Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR4	Si, Zener, 3.6V, 5%	1281-0076	Fairchild	1N747A
CR5	Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR6	Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR7	Si, Sw, 75 PRV	1281-0112	TI	1N914B
CR8	Si, Sw, 75 PRV	1281-0112	TI	1N914B
CR9	Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR10	Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR11	Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR12	Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR13	Not used			
CR14	Si, Sw, 75 PRV	1281-0112	TI	1N914B
CR15	Si, Sw, 75 PRV	1281-0112	TI	1N914B

SYNCHRONOUS DETECTOR, 2200 (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	TRANSISTORS			
Q1	PNP, Si, Low Pwr	1272-0024	Fairchild	2N4249
Q2	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q3	NPN, Si, Low Pwr	1272-0059	Fairchild	2N5962
Q4	PNP, Si, Low Pwr	1272-0024	Fairchild	2N4249
Q5	Si, J-Fet, N-Chan	1272-0055	Teledyne	2N4393
Q6	PNP, Si, Low Pwr	1272-0024	Fairchild	2N4249
Q7	PNP, Si, Low Pwr	1272-0024	Fairchild	2N4249
Q8	PNP, Si, Low Pwr	1272-0090	Fairchild	2N4126
Q9	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q10	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q11	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q12	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q13	Si, J-Fet, N-Chan	1272-0055	Teledyne	2N4393
Q14	Si, J-Fet, N-Chan	1272-0055	Teledyne	2N4393
Q15	PNP, Si, Low Pwr	1272-0090	Fairchild	2N4126
Q16	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q17	PNP, Si, Low Pwr	1272-0090	Fairchild	2N4126
Q18	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q19	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q20	PNP, Si, Low Pwr	1272-0024	Fairchild	2N4249
Q21	NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
	RESISTORS			
R1	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R2	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R3	Comp, 33K, 5%, 1/4W	1066-3335	Allen Bradley	CB3335
R4	Comp, 33K, 5%, 1/4W	1066-3335	Allen Bradley	CB3335
R5	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R6	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R7	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R8	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R9	MF, 51.1K, 1%, 100 PPM	1075-0099	Dale	MF 1/8 T1
R10	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R11	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R12	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R13	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R14	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R15	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R16	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R17	MF, 24.3K, 1%, 100 PPM	1075-0097	Dale	MFF 1/8 T1
R18	MF, 29.4K, 1%, 100 PPM	1074-0092	Dale	MFF 1/8 T2
R19	MF, 16.9K, 1%, 100 PPM	1075-0059	Dale	MFF 1/8 T1
R20	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R21	MF, 8.25K, 1%, 100 PPM	1075-0014	Dale	MFF 1/8 T1
R22	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R23	MF, 78.7K, 1%, 100 PPM	1075-0060	Dale	MFF 1/8 T1
R24	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R25	MF, 21.5K, 1%, 100 PPM	1075-0137	Dale	MFF 1/8 T1

SYNCHRONOUS DETECTOR, 2200 (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R26	MF, 16.9K, 1%, 100 PPM	1075-0059	Dale	MFF 1/8 T1
R27	MF, 51.1K, 1%, 100 PPM	1075-0099	Dale	MFF 1/8 T1
R28	MF, 16.9K, 1%, 100 PPM	1075-0059	Dale	MFF 1/8 T1
R29	MF, 43.2K, 1%, 100 PPM	1075-0117	Dale	MFF 1/8 T1
R30	MF, 16.9K, 1%, 100 PPM	1075-0059	Dale	MFF 1/8 T1
R31	MF, 43.2K, 1%, 100 PPM	1075-0117	Dale	MFF 1/8 T1
R32	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R33	MF, 28.7K, 1%, 100 PPM	1075-1057	Dale	MFF 1/8 T1
R34	MF, 8.25K, 1%, 100 PPM	1075-0014	Dale	MFF 1/8 T1
R35	MF, 16.9K, 1%, 100 PPM	1075-0059	Dale	MFF 1/8 T1
R36	MF, 29.4K, 1%, 100 PPM	1074-0092	Dale	MFF 1/8 T2
R37	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R38	Comp, 20K, 5%, 1/4W	1066-2035	Allen Bradley	CB2035
R39	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R40	Comp, 5.1 Meg, 5%, 1/4W	1066-5155	Allen Bradley	CB5155
R41	Comp, 150K, 5%, 1/4W	1066-1545	Allen Bradley	CB1545
R42	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R43	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R44	MF, 16.9K, 1%, 100 PPM	1075-0059	Dale	MFF 1/8 T1
R45	MF, 16.9K, 1%, 100 PPM	1075-0059	Dale	MFF 1/8 T1
R46	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R47	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R48	Comp, 20K, 5%, 1/4W	1066-2035	Allen Bradley	CB2035
R49	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R50	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R51	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R52	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R53	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R54	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R55	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R56	Comp, 15K, 5%, 1/4W	1066-1535	Allen Bradley	CB1535
R57	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R58	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R59	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R60	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R61	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R62	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R63	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R64	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R65	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R66	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R67	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R68	Comp, 1 Meg, 5%, 1/4W	1066-1055	Ohmite	OC1055
R69	Comp, 100K, 5%, 1/4W	1066-1045	Allen Bradley	CB1045
R70	Comp, 100K, 5%, 1/4W	1066-1045	Allen Bradley	CB1045
R71	Comp, 100K, 5%, 1/4W	1066-1045	Allen Bradley	CB1045
R72	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R73	Trim, Pot, 10K, 10%, 3/4W, 15T Cermet	1215-0014	Helitrim	89WR10K
R74	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R75	Comp, 33K, 5%, 1/4W	1066-3335	Allen Bradley	CB3335

SYNCHRONOUS DETECTOR, 2200 (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R76	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R77	MF, 20K, 5%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R78	Trim, Pot, 5K, 10%, 3/4W, 15T Cermet	1215-0012	Helitrim	89WR5K
R79	MF, 4.02K, 1% 25 PPM	1074-1026	Dale	MFF 1/10 T9
R80	MF, 68.1K, 1%, 100 PPM	1075-0136	Dale	MFF 1/8 T1
R81	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R82	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R83	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R84	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R85	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R86	MF, 24.3K, 1%, 100 PPM	1075-0097	Dale	MFF 1/8 T1
R87	MF, 130K, 1%, 100 PPM	1075-0114	Dale	MFF 1/8 T1
R88	Comp, 5.1 Meg, 5%, 1/4W	1066-5155	Allen Bradley	CB5155
R89	WW, 1K, 1%, .3W, +3500 PPM	1177-0012	Jordan	J120B+3400PPM
R90	Comp, 2K, 5%, 1/4W	1066-2025	Allen Bradley	CB2025
R91	MF, 24.3K, 1%, 100 PPM	1075-0097	Dale	MFF 1/8 T1
R92	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R93	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R94	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R95	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R96	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R97	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R98	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R99	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R100	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R101	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R102	MF, 51.1K, 1%, 100 PPM	1075-0099	Dale	MFF 1/8 T1
R103	MF, 51.1K, 1%, 100 PPM	1075-0099	Dale	MFF 1/8 T1
R104	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R105	Comp, 5.1K, 5%, 100 PPM	1066-5125	Allen Bradley	CB5125
R106	MF, 51.1K, 1%, 100 PPM	1075-0099	Dale	MFF 1/8 T1
R107	MF, 100K, 1%, 100 PPM	1075-0105	Dale	MFF 1/8 T1
R108	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R109	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R110	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R111	MF, 51.1K, 1%, 100 PPM	1075-0099	Dale	MFF 1/8 T1
R112	Trim, Pot, 20K, 10%, 3/4W, 15T Cermet	1215-0021	Beckman	89WR20K
R113	MF, 51.1K, 1%, 100 PPM	1075-0099	Dale	MFF 1/8 T1
R114	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R115	MF, 51.1K, 1%,100 PPM	1075-0099	Dale	MFF 1/8 T1
R116	MF, 511K, 1%, 100 PPM	1075-0156	Dale	MFF 1/8 T1
R117	MF, 100K, 1%, 100 PPM	1075-0105	Dale	MFF 1/8 T1
R118	MF, 200K, 1%, 100 PPM	1075-0148	Dale	MFF 1/8 T1
R119	MF, 511K, 1%, 100 PPM	1075-0156	Dale	MFF 1/8 T1
R120	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R121	Comp, 47K, 5%, 1/4μ	1066-4735	Allen Bradley	CB4735
R122	MF, 1K, .1%, 25 PPM	1074-0050	Dale	MF 1/10 T9
R123	MF, 1K, .1%, 25 PPM	1074-0050	Dale	MF 1/10 T9
R124	Pot, 500 Ohm, 20%, 1/2W, 4T Cermet	1203-0063	Bourns	3339H-1-501
R125	MF, 10K, .1%, 25 PPM	1074-0060	Dale	MF 1/10 T9

SYNCHRONOUS DETECTOR, 2200 (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R126	MF, 10K, 1%, 25 PPM	1074-0060	Dale	MF 1/10 T9
R127	MF, 3.01K, 1% 100 PPM	1075-0127	Dale	MFF 1/8 T1
R128	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R129	MF, 4.02K, 1%, 25 PPM	1074-1026	Dale	MF 1/10 T9
R130	MF, 4.02K, 1%, 25 PPM	1074-1026	Dale	MF 1/10 T9
R131	MF, 10K, .1%, 25 PPM	1074-0060	Dale	MF 1/10 T9
R132	MF, 10K, .1%, 25 PPM	1074-0060	Dale	MF 1/10 T9
R133	MF, 4.02K, 1%, 25 PPM	1074-1026	Dale	MF 1/10 T9
R134	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R135	MF, 4.02K, 1%, 25 PPM	1074-1026	Dale	MF 1/10 T9
R136	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R137	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R138	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R139	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R140	MF, 4.53K, 1%, 100 PPM	1075-0053	Dale	MFF 1/8 T1
R141	MF, 20K, 1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R142	MF, 23.2K, 1%, 150 PPM	1074-1006	Dale	MFF 1/8 T1
R143	MF, 3.01K, 1%, 100 PPM	1075-0127	Dale	MFF 1/8 T1
R144	MF, 7.5K, 1%, 100 PPM	1075-0158	Dale	MFF 1/8 T1
R145	MF, 15K, 1%, 100 PPM	1075-0081	Dale	MFF 1/8 T1
R146	MF, 4.99K, 1%, 25 PPM	1074-1027	Dale	MF 1/10 T9
R147	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R148	MF, 15K, 1%, 100 PPM	1075-0081	Dale	MFF 1/8 T1
R149	MF, 9.09K, 1%, 100 PPM	1074-1019	Dale	MFF 1/8 T1
R150	MF, 14K, 1%, 100 PPM	1075-0016	Dale	MFF 1/8 T1
R151	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R152	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R153	MF, 23.2K, 1%, 150 PPM	1074-1006	Dale	MFF 1/8 T1
R154	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R155	Comp, 1.5K, 5%, 1/4W	1066-1525	Allen Bradley	CB1525
R156	Comp, 220K, 5%, 1/4W	1066-2245	Allen Bradley	CB2245
R157	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R158	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R159	Comp 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
	INTEGRATED CIRCUITS			
U1	Quad Voltage Comptr	2025-0201	Motorola	MLM339P
U2	J-Fet-Input Op Ampl	2025-0199	TI	TL081CP
U3	Dual Op Amp	2025-0058	Raytheon	RC4558DN
U4	Dual Monostable MV W/Clr	2025-0107	TI	SN74L123N
U5	Dual J-K Flip Flop	2025-0110	TI	SN74LS73N
U6	J-Fet-Input Op Ampl	2025-0199	TI	TL081CP
U7	Dual Op Amp	2025-0058	Raytheon	RC4558DN
U8	Quad Voltage Comptr	2025-0201	Motorola	MLM339P
U9	Dual Op Amp	2025-0058	Raytheon	RC4558DN
U10	Op Ampl	2025-0070	National	LM308N
U11	Quad 2 Input Pos NAND Gates	2025-0080	TI	SN74L03N
U12	Op Ampl	2025-0161	RCA	CA3130T
U13	Quad Bilateral Sw	2025-0193	Motorola	MC14066BCP
U14	Dual Op Amp	2025-0058	Raytheon	RC4558DN
U15	J-Fet-Input Op Ampl	2025-0199	TI	TL081CP

SYNCHRONOUS DETECTOR, 2200 (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
U16	Dual Monostable MV w/clr	2025-0107	TI	SN74L123N
U17	Xstr and Dio Array	2025-0171	Fairchild	UA3046DC
U18	Analog Switch/Multiplexer	2025-0090	Motorola	MC14016CP
U19	Op Ampl	2025-0161	RCA	CA3130T
U20	Quad Bilateral Sw	2025-0193	Motorola	MC14066BCP
U21	General Purpose Op Ampl	2025-0067	TI	UA741CP
U22	Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U23	BCD-DEC Up/Dn counter	2025-0226	Fairchild	74LS192PC
U24	Dual Monostable MV w/clr	2025-0107	TI	SN74L123N
U25	Bi-FET Op Ampl	2025-0192	TI	TL082CP
U26	Quad Bilateral Sw	2025-0193	Motorola	MC14066BCP
U27	BCD-to-DEC Decoder	2025-0195	Motorola	MC14028BP
U28	Quad Voltage Comparator	2025-0201	Motorola	MLM339P
U29	Quad Voltage Comparator	2025-0201	Motorola	MLM339P
U30	Quad 2-input NAND gate	2025-0114	TI	SN74LS00N

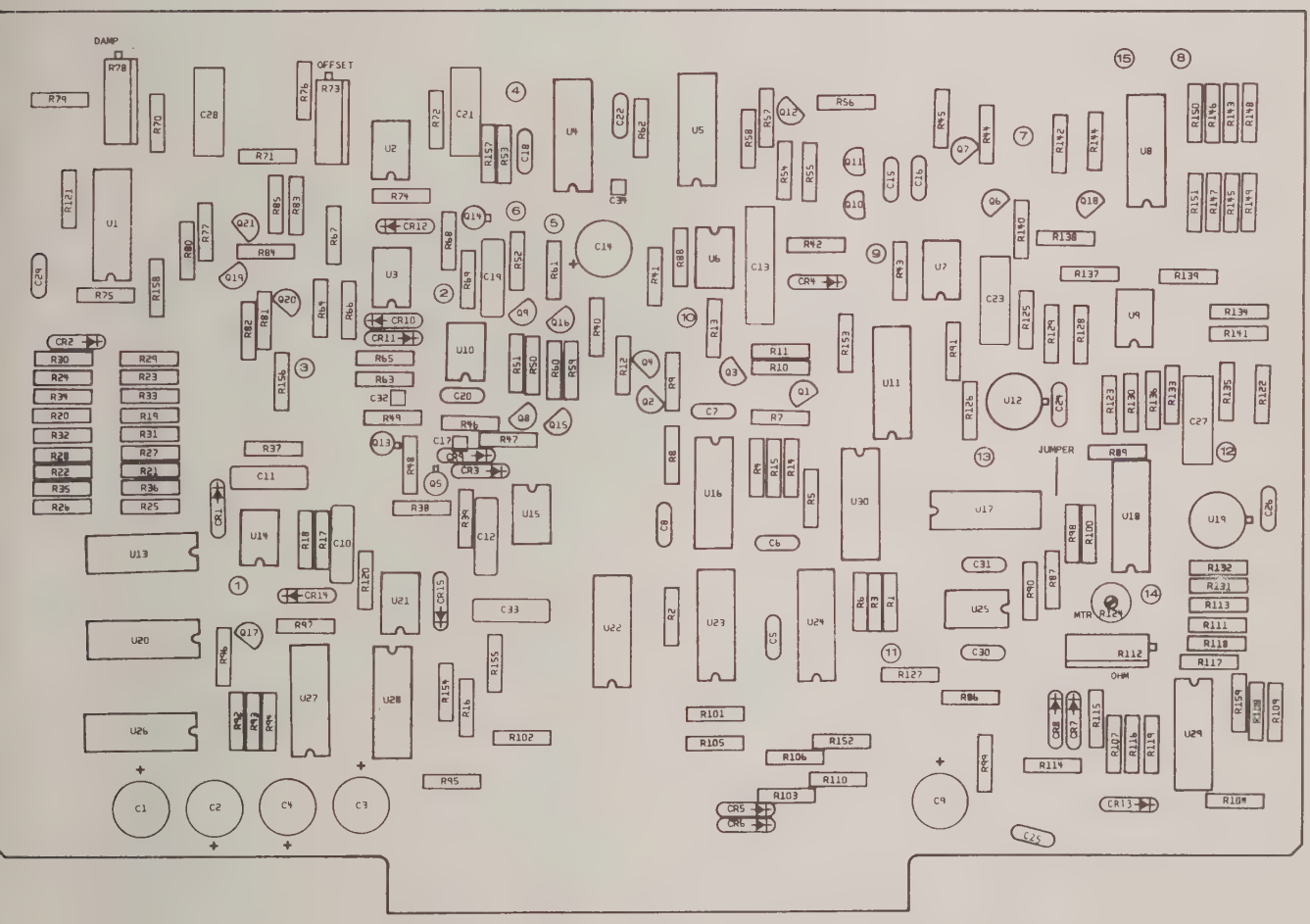


Figure 4-8. Synchronous Detector Assembly. 2200

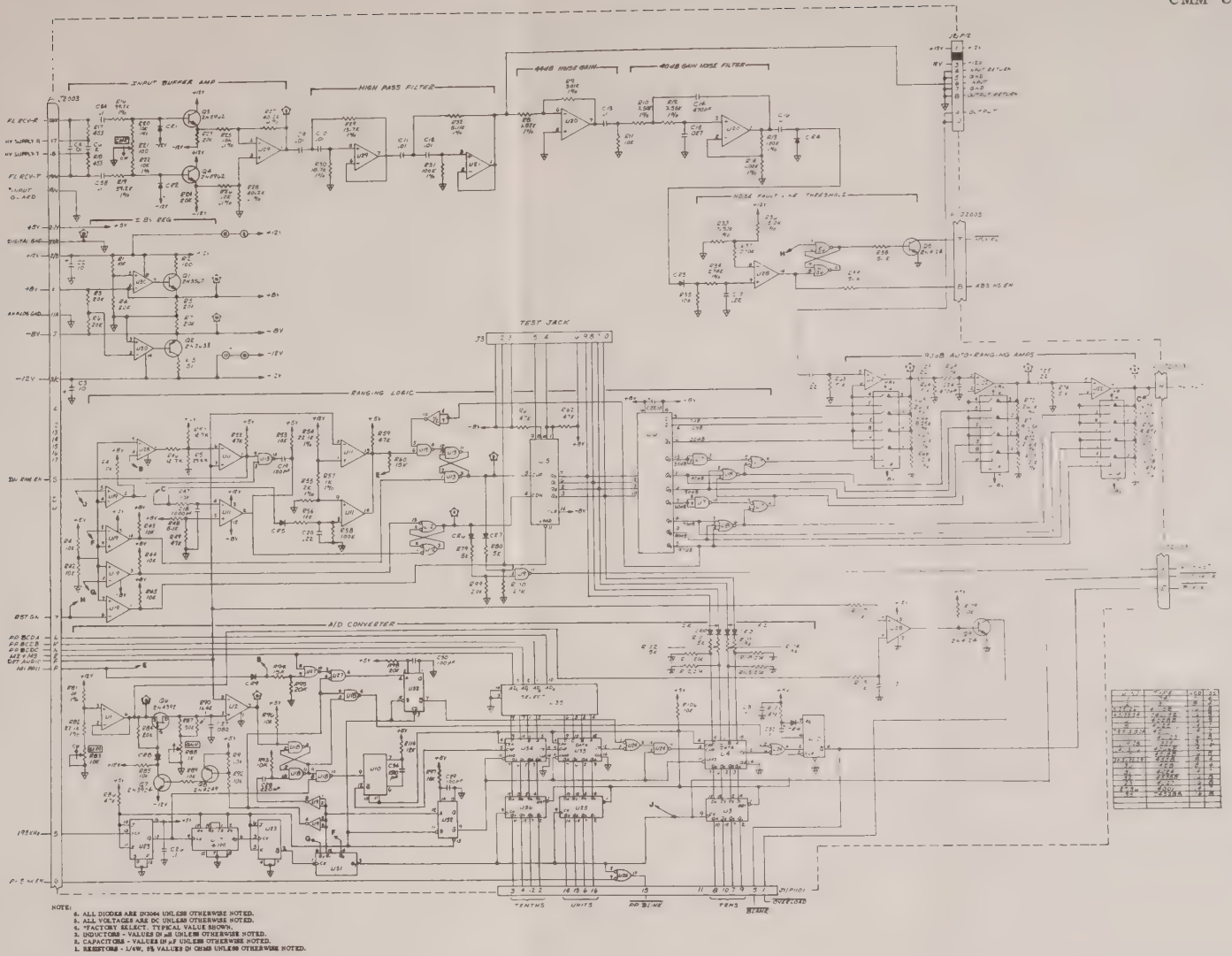

INPUT BUFFER AMP
HIGH PASS FILTER
40dB HOSE GAIN
40dB GAIN HOSE FILTER
NOISE FAULT HI THRESHOLD
TEST JACK
RANGING LOGIC
90dB AUTO-RANGING AMPS
A/D CONVERTER
TENTHS
UNITS
TENS
NOTE:
6. ALL DIODES ARE IN3064 UNLESS OTHERWISE NOTED.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.

Figure 4-7. Receiver/Converter, 2100

SEQUENCE LOGIC· 2300

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2300	Sequence Logic	7001-0523	Cushman	
	PC Board Assy	1780-0908	Cushman	
	CAPACITORS			
C1	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C2	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C3	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C4	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C5	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C6	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C7	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C8	Cer, .01μF, 10%, 200V	1005-0065	Aerovox	CK06BX103K
C9	Cer, .01μF, 10%, 200V	1005-0065	Aerovox	CK06BX103K
	RESISTORS			
R1	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R2	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R3	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R4	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R5	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R6	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R7	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R8	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R9	MF, 100K, 1%, 100 PPM	1075-0105	Dale	MFF 1/8 T1
R10	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R11	MF, 8.25K, 1%, 100 PPM	1075-0014	Dale	MFF 1/8 T1
R12	MF, 511K, 1%, 100 PPM	1075-0156	Dale	MFF 1/8 T1
R13	MF, 511K, 1%, 100 PPM	1075-0156	Dale	MFF 1/8 T1
R14	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R15	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R16	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R17	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
	INTEGRATED CIRCUITS			
U1	Triple, 3 Input NOR	2025-0206	Motorola	MC14025BCP
U2	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP
U3	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP
U4	Quad, 2 Input NAND Gate	2025-0203	Motorola	MC14011BCP
U5	Quad, 2 Input NAND Gate	2025-0203	Motorola	MC14011BCP
U6	Quad, 2 Input NAND Gate	2025-0203	Motorola	MC14011BCP
U7	Quad, D Flip Flop	2025-0200	Motorola	MC14175BCP
U8	Quad, 2 Input OR Gate	2025-0210	Motorola	MC14071BCP
U9	Hex Inverter	2025-0209	Motorola	MC14069BCP
U10	Quad, 2 Input NAND Gate	2025-0203	Motorola	MC14011BCP
U11	Triple, 3 Input NAND	2025-0205	Motorola	MC14023BCP
U12	Hex Inverter	2025-0048	TI	SN7404N
U13	Hex Invt/Buffer	2025-0189	Motorola	MC14049BP
U14	Triple, 3 Input NOR	2025-0206	Motorola	MC14025BCP
U15	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP

SEQUENCE LOGIC, 2300 (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
U16	Quad, D Flip Flop	2025-0200	Motorola	MC14175BCP
U17	Hex, Non-Invt/Buffer	2025-0208	Motorola	MC14050BCP
U18	Up/Dn Counter	2025-0227	National	MM74C193N
U19	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP
U20	Up/Dn Counter	2025-0227	National	MM74C193N
U21	Not used			
U22	Quad, Voltage Comptr	2025-0201	Motorola	MLM339P
U23	Quad, 2 Input OR Gate	2025-0210	Motorola	MC14071BCP
U24	Quad, 2 Input NAND Gate	2025-0203	Motorola	MC14011BCP
U25	BCD-to-DEC Decoder	2025-0195	Motorola	MC14028BP
U26	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP
U27	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP
U28	Up/Dn Counter	2025-0227	National	MM74C193N
U29	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP
U30	8 Channel Data Select	2025-0211	Motorola	MC14512CP
U31	Quad, 2 Input NAND Gate	2025-0203	Motorola	MC14011BCP
U32	Quad, D Flip Flop	2025-0200	Motorola	MC14175BCP
U33	Hex Inverter	2025-0209	Motorola	MC14069BCP
U34	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP
U35	Dual, BCD Up Cntr	2025-0212	Motorola	MC14518BCP
U36	Monostable MV	2025-0194	Motorola	MC14538BCP
U37	Quad, 2 Input NAND Gate	2025-0203	Motorola	MC14011BCP
U38	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP
U39	Dual, 4 Bit Shift Register	2025-0204	Motorola	MC14015BCP
U40	Quad, 2 Input NOR Gate	2025-0202	Motorola	MC14001BCP

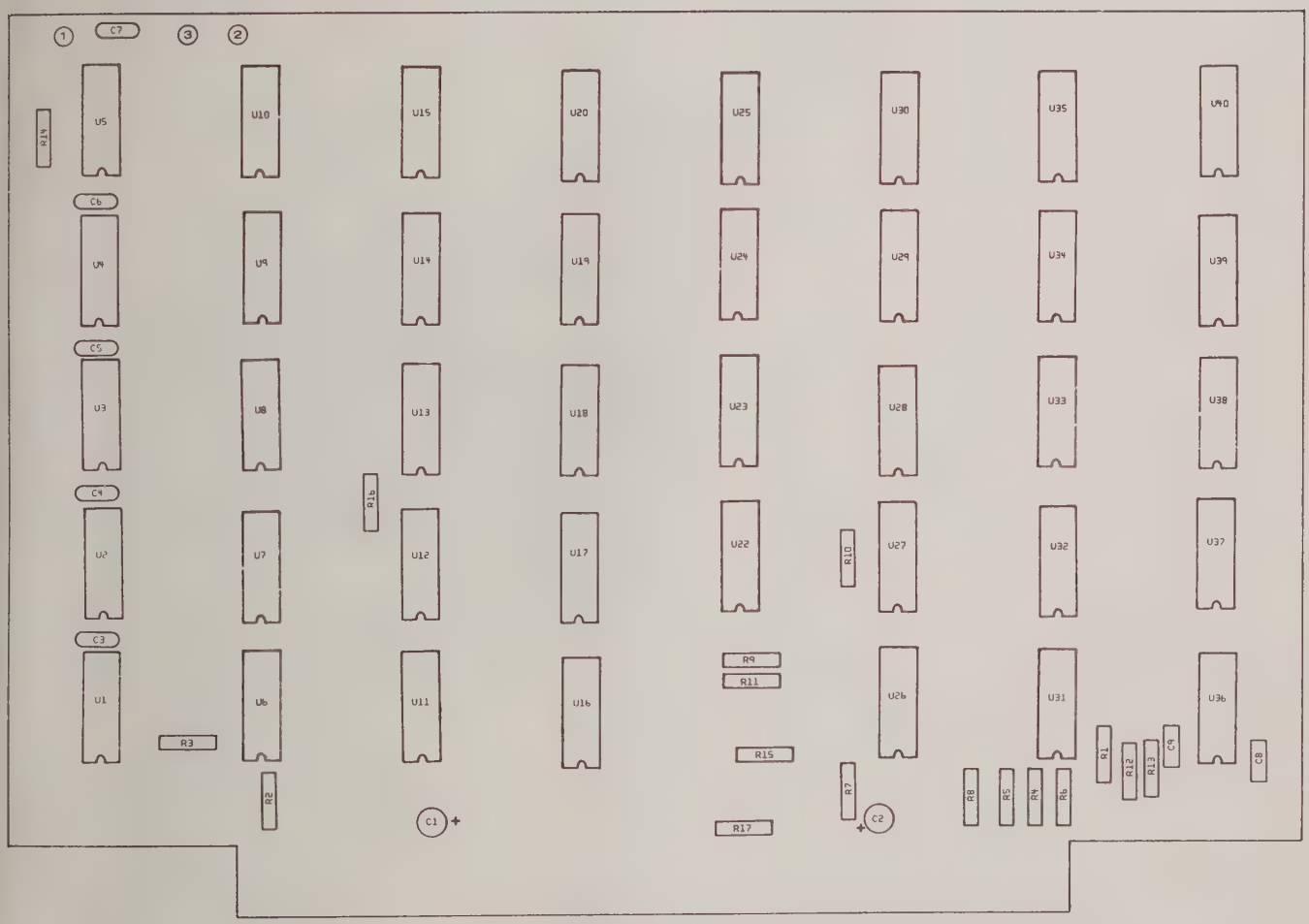


Figure 4-9. Sequence Logic Assembly. 2300

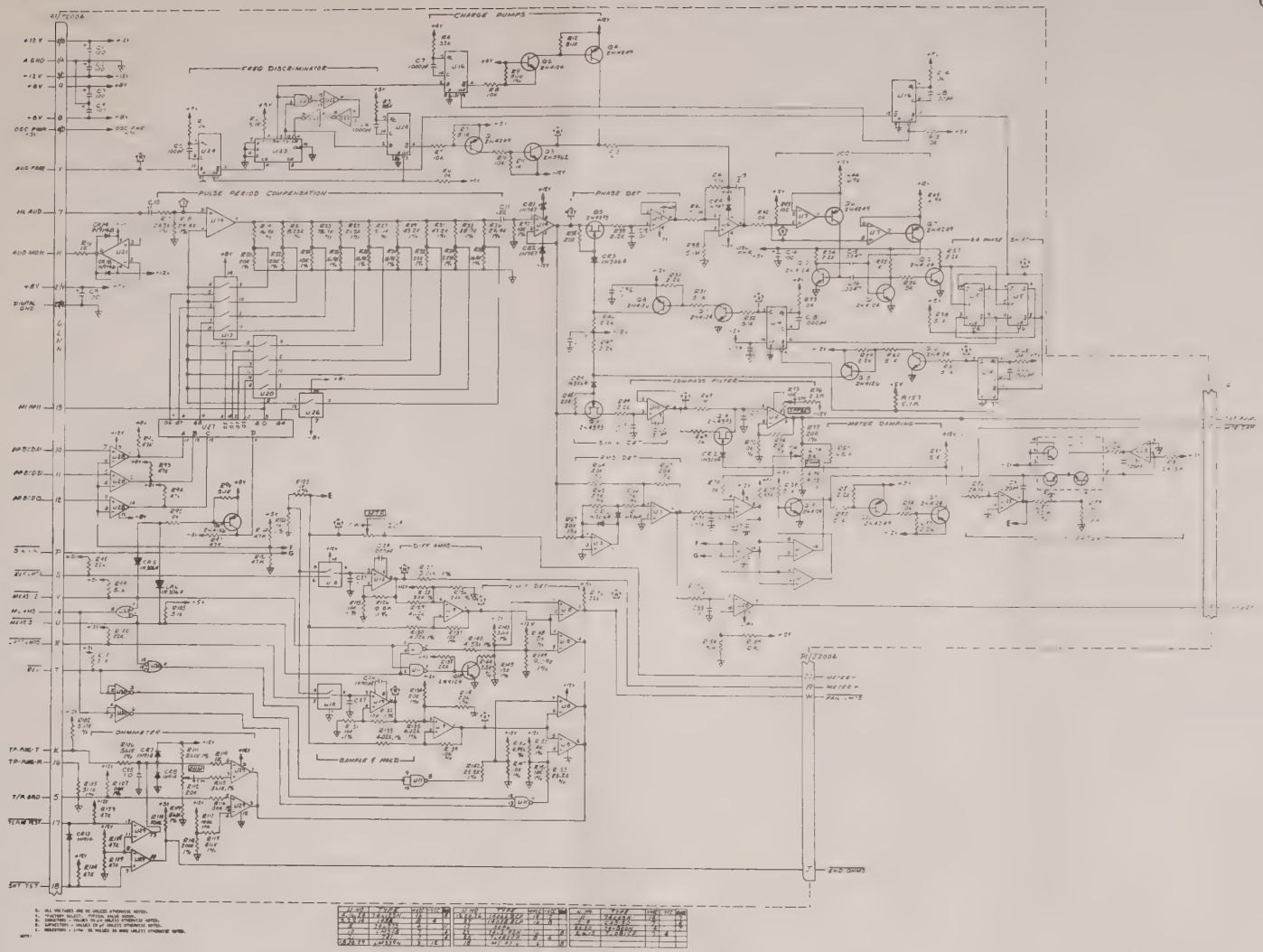


Figure 4-8. Synchronous Detector, 2200

ERROR DETECTOR. 2400 (CE-80A)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2400	Error Detector	7001-0522	Cushman	
	PC Board	1780-0902	Cushman	
	CAPACITORS			
C1	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C2	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C3	Elect, 100 μF, +50-10%, 16V	1013-0033	Matsushita	ECE-A16V100L
C4	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C5	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C6	Elect, 100 μF, +50-10%, 16V	1013-0033	Matsushita	ECE-A16V100L
C7	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C8	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C9	Elect, 100 μF, +50-10%, 16V	1013-0033	Matsushita	ECE-A16V100L
C10	Min Cer, .1 μF, 20%, 50V	1005-0097	Erie	8121-050-651-104M
C11	Mica, 51 pF, 5%, 500V	1002-0045	Elmenco	DM15-E-510J
C12	Mica, 51 pF, 5%, 500V	1002-0045	Elmenco	DM15-E-510J
C13	Tant, 10 μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C14	Tant, 10 μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C15	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C16	Min Cer, .1 μF, 20%, 50V	1005-0097	Erie	8121-050-651-104M
C17	Min Cer, .1 μF, 20%, 50V	1005-0097	Erie	8121-050-651-104M
C18	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C19	Tant, 2.2 μF, 10%, 35V	1011-0001	Sprague	196D225X9035JA1
C20	Mica, 15 pF, 5%, 500V	1002-0001	Elmenco	DM15-C-150J
C21	Min Cer, .1 μF, 20%, 50V	1005-0097	Erie	8121-050-651-104M
C22	Mica, 20 pF, 5%, 500V	1002-0060	Elmenco	DM15-E-200J
C23	Mica, 20 pF, 5%, 500V	1002-0060	Elmenco	DM15-E-200J
C24	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C25	Mica, 510 pF, 5%, 500V	1002-0036	Elmenco	DM5-F-511J
C26	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C27	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C28	Mica, 1000 pF, 5%, 500V	1002-0015	Elmenco	DM15-F-102J
C29	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C30	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C31	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C32	Polyest, .0056 μF, 10%, 100V	1008-0022	Sprague	225P56291WA3
C33	Mica, 820 pF, 5%, 300V	1002-0039	Elmenco	DM15-F-821J
C34	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C35	Trim, 9-35 pF 200V, N650 Vert	1001-0006	Erie	CV31D350
C36	Mica, 820 pF, 5%, 300V	1002-0039	Elmenco	DM15-F-821J
C37	Mica, 24 pF, 5%, 500V	1002-0051	Elmenco	DM15-C-240J
C38	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C39	Cer, .01 μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C40	Tant, 2.2 μF, 10%, 35V	1011-0001	Sprague	196D225X9035JA1
C41	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C42	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C43	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C44	Cer, .05 μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C45	Mica, 30 pF, 5%, 500V	1002-0043	Elmenco	DM15-E-300J

ERROR DETECTOR, 2400 (CE-80A) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	DIODES			
CR1	Dio, Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR2	Dio, Si, Hot Carr, 70 PRV	1283-0001	HP	5082-2800
CR3	Dio, Si, Hot Carr, 70 PRV	1283-0001	HP	5082-2800
CR4	Dio, Si, Hot Carr, 70 PRV	1283-0001	HP	5082-2800
CR5	Dio, Si, Hot Carr, 70 PRV	1283-0001	HP	5082-2800
CR6	Dio, Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR7	Dio, Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR8	Dio, Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR9	Dio, Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR10	Not used			
CR11	Dio, Si, Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR12	Dio, Si, Varicap, 29 pF, 30 PRV	1281-0064	Motorola	MV109
	INDUCTORS			
L1	Choke, 2 1/2 Turn Wideband, 4B	1586-0003	Ferroxcube	VK20020/4B
L2	Choke, 2 1/2 Turn Wideband, 4B	1586-0003	Ferroxcube	VK20020/4B
L3	Choke, 2 1/2 Turn Wideband, 4B	1586-0003	Ferroxcube	VK20020/4B
L4	Not used			
L5	RF Choke, 100 μH, 5%	1585-0017	Delevan	1537-76
L6	Coil, Variable IF	1596-0216	Cushman	
	TRANSISTORS			
Q1	Si, PNP, Low Pwr	1272-0090	Fairchild	2N4126
Q2	Si, NPN, Low Pwr	1272-0091	Fairchild	2N4124
Q3	Si, PNP, Low Pwr/Sw	1272-0037	Motorola	2N3906
Q4	Si, PNP, Low Pwr	1272-0090	Fairchild	2N4126
Q5	Si, PNP, Low Pwr	1272-0090	Fairchild	2N4126
Q6	Si, NPN, Low Pwr	1272-0022	Fairchild	2N3563
Q7	Si, NPN, Low Pwr	1272-0091	Fairchild	2N4124
Q8	Si, NPN, Low Pwr	1272-0091	Fairchild	2N4124
Q9	Si, NPN, Low Pwr	1272-0091	Fairchild	2N4124
Q10	Si, NPN, Low Pwr	1272-0022	Fairchild	2N3563
	RESISTORS			
R1	Comp, 15 Ohm, 5%, 1/4W	1066-1505	Allen Bradley	CB1505
R2	Comp, 15 Ohm, 5%, 1/4W	1066-1505	Allen Bradley	CB1505
R3	Comp, 51 Ohm, 5%, 1/4W	1066-5105	Allen Bradley	CB5105
R4	MF, 150 Ohm, 1%, 100 PPM	1075-0125	Dale	MFF 1/8 T1
R5	MF, 150 Ohm, 1%, 100 PPM	1075-0125	Dale	MFF 1/8 T1
R6	Comp, 51 Ohm, 5%, 1/4W	1066-5105	Allen Bradley	CB5105
R7	Comp, 1.6K, 5%, 1/4W	1066-1625	Allen Bradley	CB1625
R8	MF, 51.1K, 1%, 100 PPM	1075-0099	Dale	MFF 1/8 T1
R9	MF, 1K, 1%, 100 PPM	1075-0037	Dale	MFF 1/8 T1
R10	MF, 1.5K, 1%, 100 PPM	1075-0039	Dale	MFF 1/8 T1
R11	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R12	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R13	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R14	Comp, 3K, 5%, 1/4W	1066-3025	Allen Bradley	CB3025
R15	Comp, 2.4K, 5%, 1/4W	1066-2425	Allen Bradley	CB2425

ERROR DETECTOR, 2400 (CE-80A) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R16	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R17	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R18	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R19	Comp, 150 Ohm, 5%, 1/4W	1066-1515	Allen Bradley	CB1515
R20	Comp, 470 Ohm, 5%, 1/4W	1066-4715	Allen Bradley	CB4715
R21	Comp, 1.5K, 5%, 1/4W	1066-1525	Allen Bradley	CB1525
R22	Comp, 220 Ohm, 5%, 1/4W	1066-2215	Allen Bradley	CB2215
R23	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R24	Comp, 300 Ohm, 5%, 1/4W	1066-3015	Allen Bradley	CB3015
R25	Comp, 330 Ohm, 5%, 1/4 W	1066-3315	Allen Bradley	CB3315
R26	Comp, 330 Ohm, 5%, 1/4W	1066-3315	Allen Bradley	CB3315
R27	Comp, 300 Ohm, 5%, 1/4W	1066-3015	Allen Bradley	CB3015
R28	Comp, 510 Ohm, 5%, 1/4W	1066-5115	Allen Bradley	CB5115
R29	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R30	Comp, 100K, 5%, 1/4W	1066-1045	Allen Bradley	CB1045
R31	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R32	Comp, 68K, 5%, 1/4W	1066-6835	Allen Bradley	CB6835
R33	Comp, 1 Meg, 5%, 1/4W	1066-1055	Ohmite	OC1055
R34	Comp, 1.8K, 5%, 1/4W	1066-1825	Allen Bradley	CB1825
R35	Comp, 1.8K, 5%, 1/4W	1066-1825	Allen Bradley	CB1825
R36	Comp, 120K, 5%, 1/4W	1066-1245	Allen Bradley	CB1245
R37	Comp, 120K, 5%, 1/4W	1066-1245	Allen Bradley	CB1245
R38	MF, 100K, 1%, 100 PPM	1075-0105	Dale	MFF 1/8 T1
R39	MF, 9.09K, 1%, 100 PPM	1074-1019	Dale	MFF 1/8 T1
R40	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R41	MF, 6.81K, 1%, 100 PPM	1075-0140	Dale	MFF 1/8 T1
R42	MF, 14.7K, 1%, 150 PPM	1074-1020	Dale	MFF 1/8 T1
R43	Comp, 3.3K, 5%, 1/4W	1066-3325	Allen Bradley	CB3325
R44	Comp, 2K, 5%, 1/4W	1066-2025	Allen Bradley	CB2025
R45	Comp, 24K, 5%, 1/4W	1066-2435	Allen Bradley	CB2435
R46	Comp, 16K, 5%, 1/4W	1066-1635	Allen Bradley	CB1635
R47	Comp, 150 Ohm, 5%, 1/4W	1066-1515	Allen Bradley	CB1515
R48	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R49	Comp, 150 Ohm, 5%, 1/4W	1066-1515	Allen Bradley	CB1515
R50	Comp, 680 Ohm, 5%, 1/4W	1066-6815	Allen Bradley	CB6815
R51	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R52	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R53	Comp, 510 Ohm, 5%, 1/4W	1066-5115	Allen Bradley	CB5115
R54	Comp, 43K, 5%, 1/4W	1066-4335	Allen Bradley	CB4335
R55	Comp, 75 Ohm, 5%, 1/4W	1066-7505	Allen Bradley	CB7505
R56	Comp, 1.8K, 5%, 1/4W	1066-1825	Allen Bradley	CB1825
R57	Comp, 510 Ohm, 5%, 1/4W	1066-5115	Allen Bradley	CB5115
R58	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R59	Comp, 100 Ohm, 5%, 1/4W	1066-1015	Allen Bradley	CB1015
R60	Comp, 9.1K, 5%, 1/4W	1066-9125	Allen Bradley	CB9125
R61	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R62	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R63	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R64	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R65	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025

ERROR DETECTOR, 2400 (CE-80A) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R66	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R67	Comp, 22K, 5%, 1/4W	1066-2235	Allen Bradley	CB2235
R68	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R69	Comp, 47K, 5%, 1/4W	1066-4735	Allen Bradley	CB4735
R70	Comp, 150 Ohm, 5%, 1/4W	1066-1515	Allen Bradley	CB1515
R71	Comp, 9.1K, 5%, 1/4W	1066-9125	Allen Bradley	CB9125
R72	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R73	Comp, 300 Ohm, 5%, 1/4W	1066-3015	Allen Bradley	CB3015
R74	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R75	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R76	MF, 33.2K, 1%, 100 PPM	1075-0098	Dale	MFF 1/8 T1
R77	Pot, 1K, 10%, 1/2W, 1T Cermet	1215-0052	Allen Bradley	A2A102
R78	MF, 33.2K, 1%, 100 PPM	1075-0098	Dale	MFF 1/8 T1
	TRANSFORMERS			
T1	Xfmr, Pulse 1:1:1, 500 mH	1576-0013	Pulse Eng	PE5762
T2	Xfmr, Trifilar Coil	1579-0017	Cushman	
	INTEGRATED CIRCUITS			
U1	Hi Spd Differential Comptr	2025-0028	Fairchild	710HC
U2	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U3	Dual J-K, Flip Flop	2025-0110	TI	SN74LS73N
U4	Dual D, Flip Flop	2025-0124	TI	SN74LS74N
U5	Quad, 2 INP, Excl OR	2025-0219	National	DM74LS86N
U6	Dual Monostable MV	2025-0107	TI	SN74L123N
U7	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U8	Dual, 4 INP, NAND	2025-0216	National	DM74LS20N
U9	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U10	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U11	Quad, 2 INP, Pos NAND Gate	2025-0117	TI	SN74S00N
U12	Quad, 2 INP, Pos NOR Gates	2025-0108	TI	SN74LS02N
U13	Hex Invertor	2025-0084	TI	SN74LS04N
U14	Dual, 5 INP, NOR	2025-0229	Signetics	N74LS260A
U15	J-FET-INP, Op Amp	2025-0199	TI	TL081CP
U16	Dual, J-K, Flip Flop	2025-0110	TI	SN74LS73N
U17	Dual, D, Flip Flop	2025-0124	TI	SN74LS74N
U18	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U19	UP/DN Counter	2025-0228	National	DM74LS193N
U20	Shift Registers	2025-0224	National	DM74LS164N
U21	Bifet, Op Ampl	2025-0192	TI	TL082CP
U22	Quad, 2 INP, NOR	2025-0214	National	DM74503N
U23	Dual Line Receiver	2025-0140	TI	SN75107AN
U24	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U25	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U26	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U27	Shift Registers	2025-0224	National	DM74LS164N
U28	Dual 5 Input NOR	2025-0229	Signetics	N74LS260A
U29	Dual Op Amp	2025-0058	Raytheon	RC4558DN
U30	Xstr and Dio Array	2025-0171	Fairchild	UA3046DC

ERROR DETECTOR. 2400. (CE-80A). cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
U31	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U32	Monostable, MV	2025-0194	Motorola	MC14538BCP
U33	Dual D, Flip Flop	2025-0124	TI	SN74LS74N
U34	Dual D, Flip Flop	2025-0124	TI	SN74LS74N

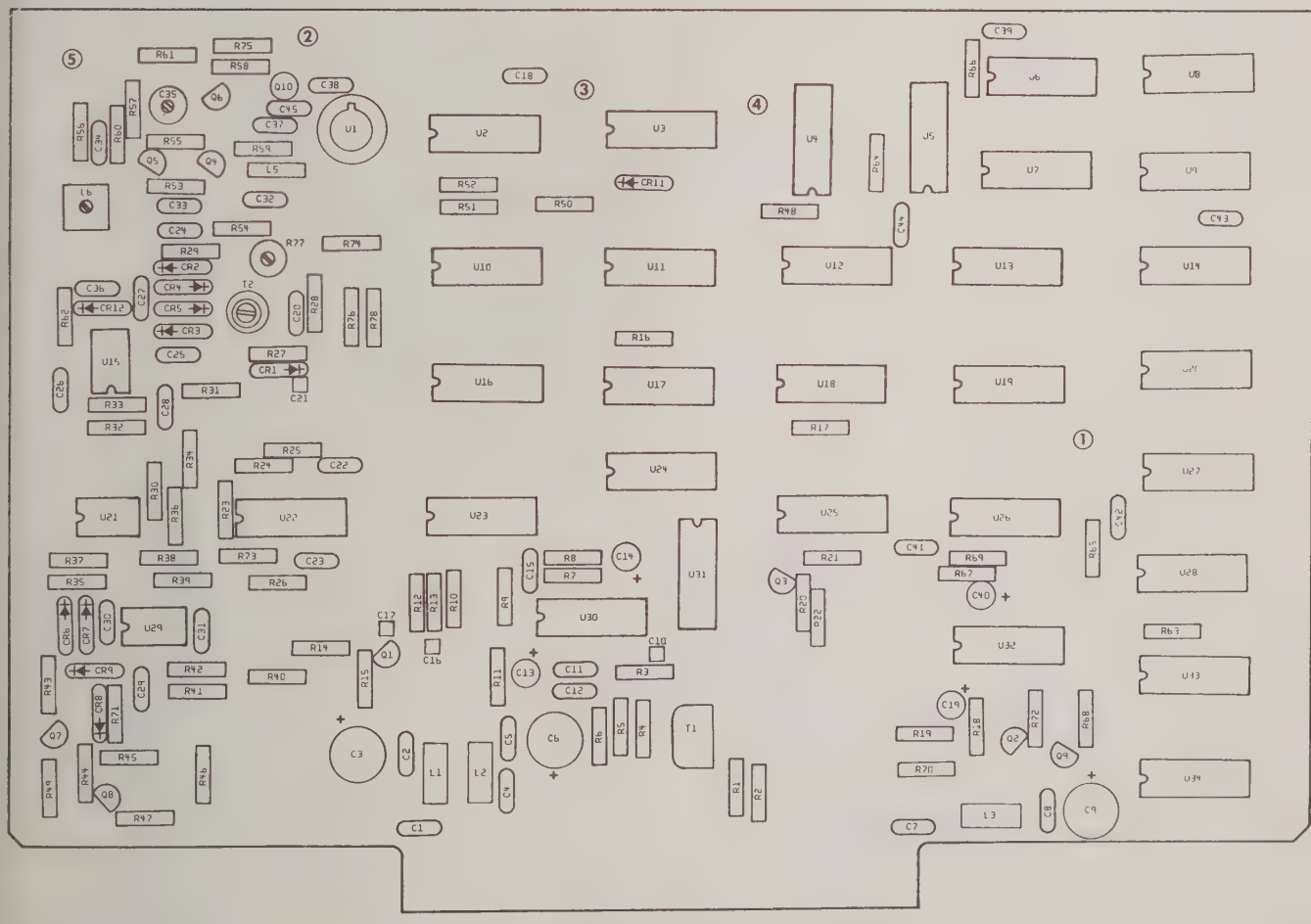


Figure 4-10. Error Detector Assembly. (CE-80A) 2400

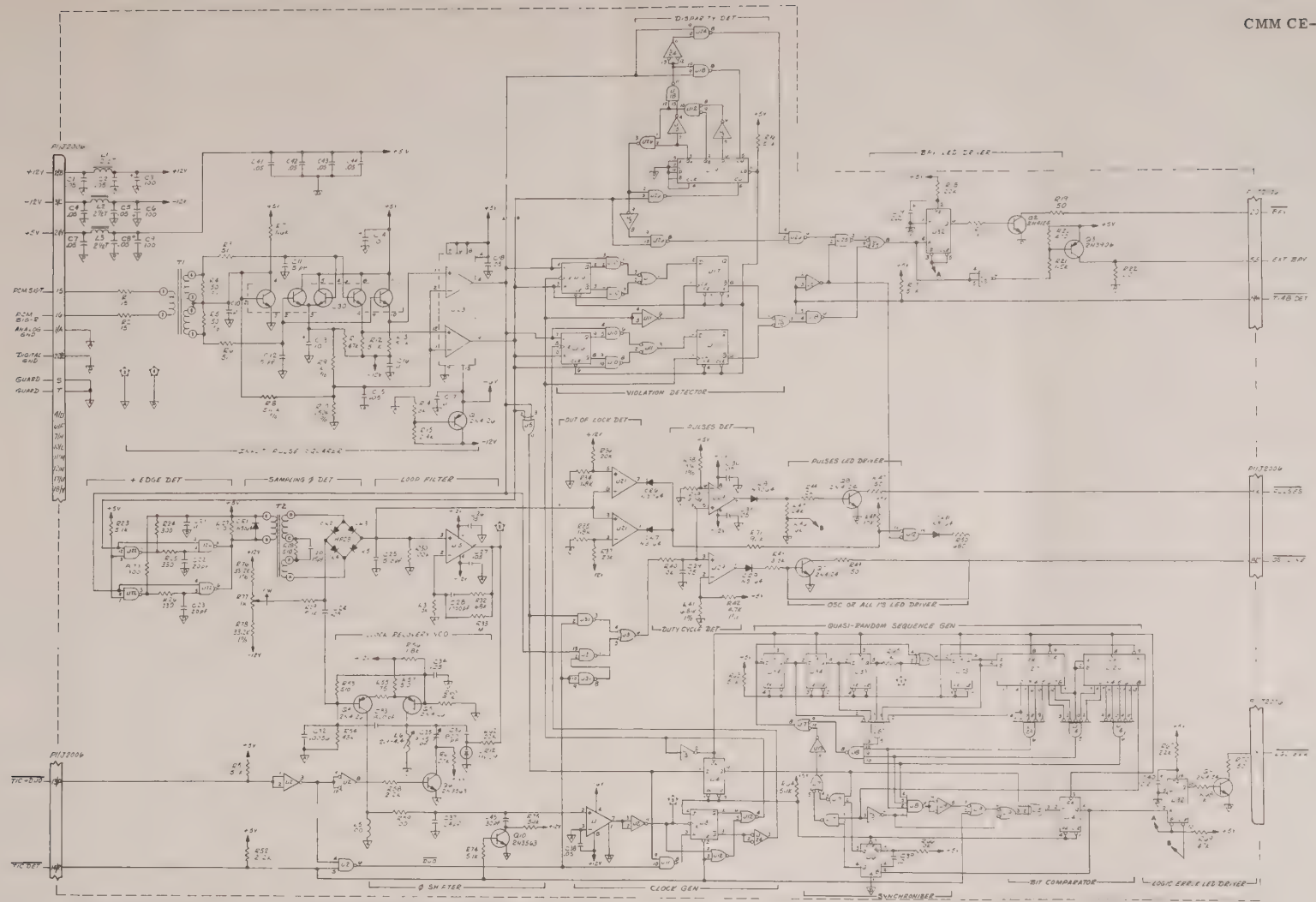


Figure 4-10. Error Detector (CE-80A), 2400

ERROR DETECTOR. 2400 (CE-80B)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2400	Error Detector	7001-0605	Cushman	
	PC Board Assy	1780-0913	Cushman	
	CAPACITORS			
C1	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C2	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C3	Elect, 100μF, -10+75%, 16V	1013-0033	Panasonic	ECEA1CV101S
C4	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C5	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C6	Elect, 100μF, -10+75%, 16V	1013-0033	Panasonic	ECEA1CV101S
C7	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C8	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C9	Elect, 100μF, -10+75%, 16V	1013-0033	Panasonic	ECEA1CV101S
C10	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C11	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C12	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C13	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C14	Min cer, .1μF, ±20%, 50V	1005-0097	Erie	8121-050-651-104M
C15	Mica, 51pF, ±5%, 500V	1002-0045	Elmenco	DM15-E-510J
C16	Mica, 51pF, ±5%, 500V	1002-0045	Elmenco	DM15-E-510J
C17	Tant, 10μF, ±20%, 35V	1011-0006	Matsuo	221L3502106M3
C18	Tant, 10μF, ±20%, 35V	1011-0006	Matsuo	221L3502106M3
C19	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C20	Min cer, .1μF, ±20%, 50V	1005-0097	Erie	8121-050-651-104M
C21	Min cer, .1μF, ±20%, 50V	1005-0097	Erie	8121-050-651-104M
C22	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C23	Cer, .022μF, ±10%, 100V	1005-0079	Aerovox	CK06BX223K
C24	Tant, 2.2μF, ±10%, 35V	1011-0001	Sprague	196D225X9035JA1
C25	Min cer, 1500pF, ±5%, 100V	1005-0128	Centre	200-100-NPO-152J
C26	Not used			
C27	Not used			
C28	Not used			
C29	Min cer, .1μF, ±20%, 50V	1005-0097	Erie	8121-050-651-104M
C30	Mica, 20pF, ±5%, 500V	1002-0060	Elmenco	DM15-E-200J
C31	Mica, 20pF, ±5%, 500V	1002-0060	Elmenco	DM15-E-200J
C32	Mica, 15pF, ±5%, 500V	1002-0001	Elmenco	DM15-C-150J
C33	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C34	Mica, 510pF, ±5%, 500V	1002-0036	Elmenco	DM15-F-511J
C35	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C36	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C37	Mica, 1000pF, ±5%, 500V	1002-0015	Elmenco	DM15-F-102J
C38	Polyest, .0056μF, ±10%, 100V	1008-0022	Sprague	225P56291WA3
C39	Mica, 820pF, ±5%, 300V	1002-0039	Elmenco	DM15-F-821J
C40	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C41	Mica, 820pF, ±5%, 300V	1002-0039	Elmenco	DM15-F-821J
C42	Trmr, 9-35pF, 200V, V Mt	1001-0006	Erie	CV31D350
C43	Mica, 20pF, ±5%, 500V	1002-0060	Elmenco	DM15-E-200J
C44	Mica, 51pF, ±5%, 500V	1002-0045	Elmenco	DM15-E-510J
C45	Cer, .1μF, ±10%, 100V	1005-0064	Aerovox	CK06BK104K

Error Detector, 2400 (CE-80B) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
C46	Mica, 220pF, ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C47	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C48	Min cer, .1μF, ±20%, 50V	1005-0097	Erie	8121-050-651-104M
C49	Cer, .01μF, ±10%, 200V	1005-0065	Aerovox	CK06BX103K
C50	Tant, 2.2μF, ±10%, 35V	1011-0001	Sprague	196D225X9035JA1
C51	Min cer, .1μF, ±20%, 50V	1005-0097	Erie	8121-050-651-104M
C52	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C53	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
	DIODES			
CR1	Dio, Si Sw 75PRV	1281-0013	Fairchild	1N3064
CR2	Dio, Si Hot Carrier 70PRV	1283-0001	HP	5082-2800
CR3	Dio, Si Hot Carrier 70PRV	1283-0001	HP	5082-2800
CR4	Dio, Si Hot Carrier 70PRV	1283-0001	HP	5082-2800
CR5	Dio, Si Hot Carrier 70PRV	1283-0001	HP	5082-2800
CR6	Dio, Si Varicap, 29pF, 30PRV	1281-0064	Motorola	MV109
	INDUCTORS			
L1	Choke, 2 1/2 T Wideband 4B	1586-0003	Ferroxcube	VK20020/4B
L2	Choke, 2 1/2 T Wideband 4B	1586-0003	Ferroxcube	VK20020/4B
L3	Choke, 2 1/2 T Wideband 4B	1586-0003	Ferroxcube	VK20020/4B
L4	RF Choke, 100μH, ±5%	1585-0017	Delevan	1537-76
L5	Var coil, 18 T, IF	1596-0216	Cushman	
	TRANSISTORS			
Q1	PNP, Si Low Pwr	1272-0090	Fairchild	2N4126
Q2	NPN, Si Low Pwr	1272-0091	Fairchild	2N4124
Q3	PNP, Si Low Pwr/Sw	1272-0037	Motorola	2N3906
Q4	PNP, Si Low Pwr	1272-0090	Fairchild	2N4126
Q5	PNP, Si Low Pwr	1272-0090	Fairchild	2N4126
Q6	NPN, Si Low Pwr	1272-0022	Fairchild	2N3563
Q7	NPN, Si Low Pwr	1272-0022	Fairchild	2N3563
Q8	NPN, Si Low Pwr	1272-0091	Fairchild	2N4124
	RESISTORS			
R1	Comp, 51Ω, ±5%, 1/4W	1066-5105	Allen Bradley	CB5105
R2	MF, 150Ω, ±1%, 100PPM	1075-0125	Dale	MFF 1/8 T1
R3	MF, 150Ω, ±1%, 100PPM	1075-0125	Dale	MFF 1/8 T1
R4	Comp, 51Ω, ±5%, 1/4W	1066-5105	Allen Bradley	CB5105
R5	Comp, 1.6K, ±5%, 1/4W	1066-1625	Allen Bradley	CB1625
R6	MF, 51.1K, ±1%, 100PPM	1075-0099	Dale	MFF 1/8 T1
R7	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R8	MF, 1.5K, ±1%, 100PPM	1075-0039	Dale	MFF 1/8 T1
R9	Comp, 47K, ±5%, 1/4W	1066-4735	Allen Bradley	CB4735
R10	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R11	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R12	Comp, 3K, ±5%, 1/4W	1066-3025	Allen Bradley	CB3025
R13	Comp, 2.4K, ±5%, 1/4W	1066-2425	Allen Bradley	CB2425
R14	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R15	MF, 243K, ±1%, 100PPM	1075-0208	Dale	MFF 1/8 T1

Error Detector, 2400 (CE-80B) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R16	Comp, 22K, ±5%, 1/4W	1066-2235	Allen Bradley	CB2235
R17	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R18	Comp, 1K, ±5%, 1/4W	1066-1025	Allen Bradley	CB1025
R19	Comp, 150Ω, ±5%, 1/4W	1066-1515	Allen Bradley	CB1515
R20	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen Bradley	CB4715
R21	Comp, 1.5K, ±5%, 1/4W	1066-1525	Allen Bradley	CB1525
R22	Comp, 220Ω, ±5%, 1/4W	1066-2215	Allen Bradley	CB2215
R23	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R24	Comp, 300Ω, ±5%, 1/4W	1066-3015	Allen Bradley	CB3015
R25	Comp, 300Ω, ±5%, 1/4W	1066-3015	Allen Bradley	CB3015
R26	Comp, 330Ω, ±5%, 1/4W	1066-3315	Allen Bradley	CB3315
R27	Comp, 330Ω, ±5%, 1/4W	1066-3315	Allen Bradley	CB3315
R28	Comp, 300Ω, ±5%, 1/4W	1066-3015	Allen Bradley	CB3015
R29	MF, 33.2K, ±1%, 100PPM	1075-0098	Dale	MFF 1/8 T1
R30	Pot, 1K, ±10%, 1/2W	1215-0052	Allen Bradley	A2A102
R31	MF, 33.2K, ±1%, 100PPM	1075-0098	Dale	MFF 1/8 T1
R32	Comp, 510Ω, ±5%, 1/4W	1066-5115	Allen Bradley	CB5115
R33	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R34	Comp, 100K, ±5%, 1/4W	1066-1045	Allen Bradley	CB1045
R35	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R36	Comp, 68K, ±5%, 1/4W	1066-6835	Allen Bradley	CB6835
R37	Comp, 1 Meg, ±5%, 1/4W	1066-1055	Ohmite	OC1055
R38	MF, 22.6K, ±1%, 100PPM	1074-1056	Dale	MFF 1/8 T1
R39	MF, 1.5K, ±1%, 100PPM	1075-0039	Dale	MFF 1/8 T1
R40	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R41	Not used			
R42	Not used			
R43	Not used			
R44	Not used			
R45	Comp, 150Ω, ±5%, 1/4W	1066-1515	Allen Bradley	CB1515
R46	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R47	Comp, 150Ω, ±5%, 1/4W	1066-1515	Allen Bradley	CB1515
R48	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R49	Comp, 2.2K, ±5%, 1/4W	1066-2225	Allen Bradley	CB2225
R50	Comp, 510Ω, ±5%, 1/4W	1066-5115	Allen Bradley	CB5115
R51	Comp, 43K, ±5%, 1/4W	1066-4335	Allen Bradley	CB4335
R52	Comp, 2.2K, ±5%, 1/4W	1066-2225	Allen Bradley	CB2225
R53	Comp, 75Ω, ±5%, 1/4W	1066-7505	Allen Bradley	CB7505
R54	Comp, 1.8K, ±5%, 1/4W	1066-1825	Allen Bradley	CB1825
R55	Comp, 510Ω, ±5%, 1/4W	1066-5115	Allen Bradley	CB5115
R56	Comp, 2.2K, ±5%, 1/4W	1066-2225	Allen Bradley	CB2225
R57	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen Bradley	CB1015
R58	Comp, 9.1K, ±5%, 1/4W	1066-9125	Allen Bradley	CB9125
R59	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R60	Comp, 22K, ±5%, 1/4W	1066-2235	Allen Bradley	CB2235
R61	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R62	Comp, 22K, ±5%, 1/4W	1066-2235	Allen Bradley	CB2235
R63	Comp, 75Ω, ±5%, 1/4W	1066-7505	Allen Bradley	CB7505
R64	Comp, 2.2K, ±5%, 1/4W	1066-2225	Allen Bradley	CB2225
R65	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125

Error Detector, 2400 (CE-80B) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R66	Comp, 1K, ±5%, 1/4W	1066-1025	Allen Bradley	CB1025
R67	MF, 8.66K, ±1%, 100PPM	1075-0184	Shelly Rod.	RN55D
R68	Comp, 22K, ±5%, 1/4W	1066-2235	Allen Bradley	CB2235
R69	Comp, 1K, ±5%, 1/4W	1066-1025	Allen Bradley	CB1025
R70	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R71	Comp, 150Ω, ±5%, 1/4W	1066-1515	Allen Bradley	CB1515
R72	Comp, 15Ω, ±5%, 1/4W	1066-1505	Allen Bradley	CB1505
R73	Comp, 15Ω, ±5%, 1/4W	1066-1505	Allen Bradley	CB1505
R74	Comp, 150Ω, ±5%, 1/4W	1066-1515	Allen Bradley	CB1515
	TRANSFORMERS			
T1	Xfmr, Pulse, 1:1:1 500μF	1576-0013	Pulse Eng	PE5762
T2	Xfmr assy, Trifilar coil	1579-0017	Cushman	
	INTEGRATED CIRCUITS			
U1	IC, Hi-Speed Diff Comptr	2025-0028	Fairchild	710HC
U2	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U3	IC, Dual J-K Flip Flop	2025-0110	TI	SN74LS73N
U4	IC, Dual D Flip Flop	2025-0124	TI	SN74LS74N
U5	IC, Quad 2-input Exclusive OR	2025-0219	National	DM74LS86N
U6	IC, Monostable Multivibrator	2025-0186	TI	SN74LS123N
U7	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U8	IC, Dual 4-input NAND gate	2025-0216	National	DM74LS20N
U9	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U10	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U11	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U12	IC, Quad 2-input NOR gate	2025-0108	TI	SN74LS02N
U13	IC, Hex Inverter	2025-0084	TI	SN74LS04N
U14	IC, Dual 5-input NOR	2025-0229	Signetics	N74LS260A
U15	IC, J-FET input Op Ampl	2025-0199	TI	TL081CP
U16	IC, Dual J-K Flip Flop	2025-0110	TI	SN74LS73N
U17	IC, Dual D Flip Flop	2025-0124	TI	SN74LS74N
U18	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U19	IC, Up/Dn Counter	2025-0228	National	DM74LS193N
U20	IC, Shift Register	2025-0224	National	DM74LS164N
U21	IC, Monostable Multivibrator	2025-0186	TI	SN74LS123N
U22	IC, Quad 2-input NOR	2025-0214	National	DM74S03N
U23	IC, Dual Line Receiver	2025-0140	TI	SN75107AN
U24	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U25	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U26	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U27	IC, Shift Register	2025-0224	National	DM74LS164N
U28	IC, Dual 5-input NOR	2025-0229	Signetics	N74LS260A
U29	IC, Dual J-K Flip Flop	2025-0110	TI	SN74LS73N
U30	IC, Dual 4-input NAND	2025-0216	National	DM74LS20N
U31	IC, Xstr and Diode Array	2025-0171	RCA	CA3046
U32	IC, Monostable Multivibrator	2025-0194	Motorola	MC14538BCP
U33	IC, Dual D Flip Flop	2025-0124	TI	SN74LS74N
U34	Not used			
U35	IC, Hex Inverter Buffer/Driver	2025-0093	TI	SN7406N
U36	IC, Dual D Flip Flop	2025-0124	TI	SN74LS74N

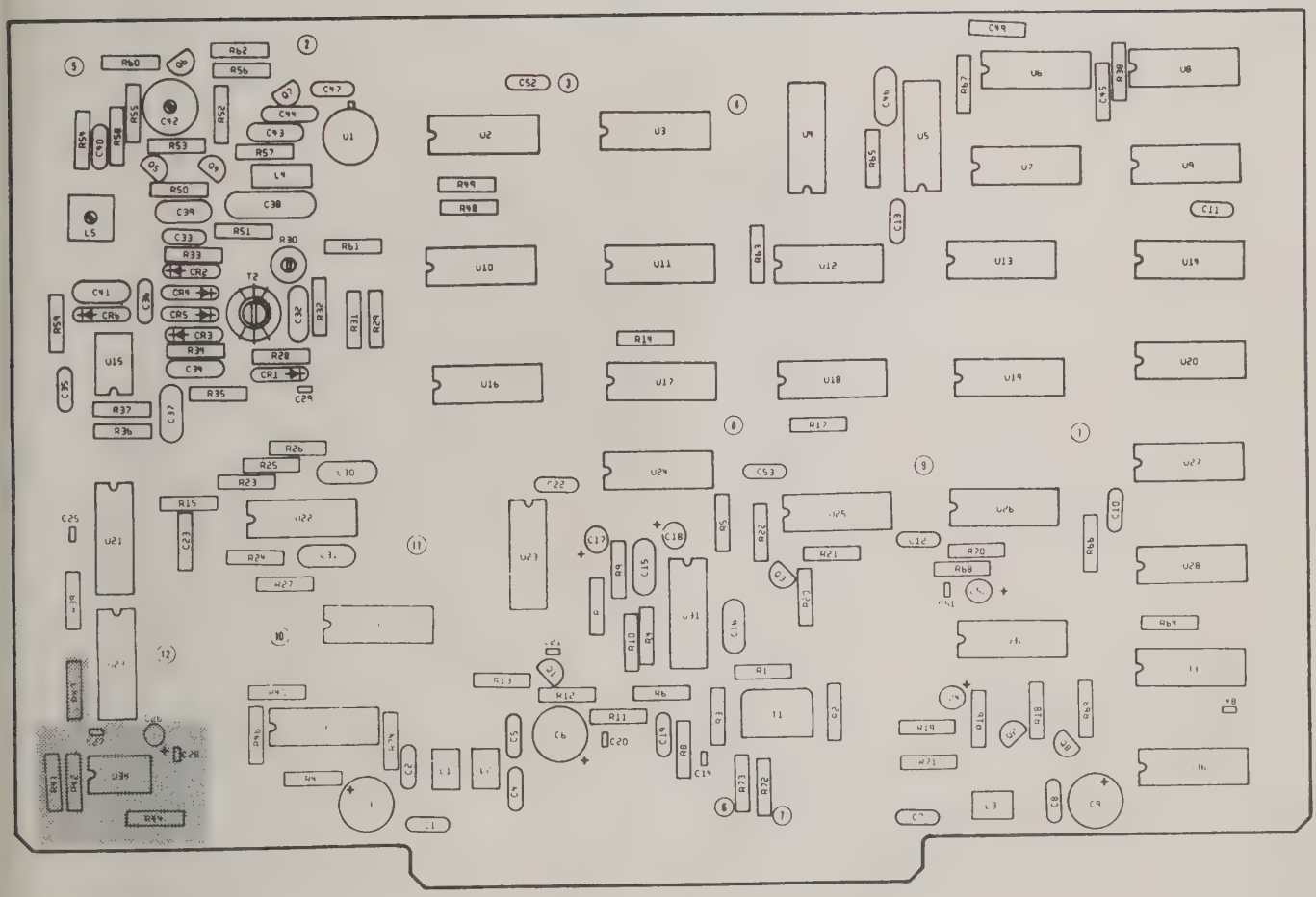
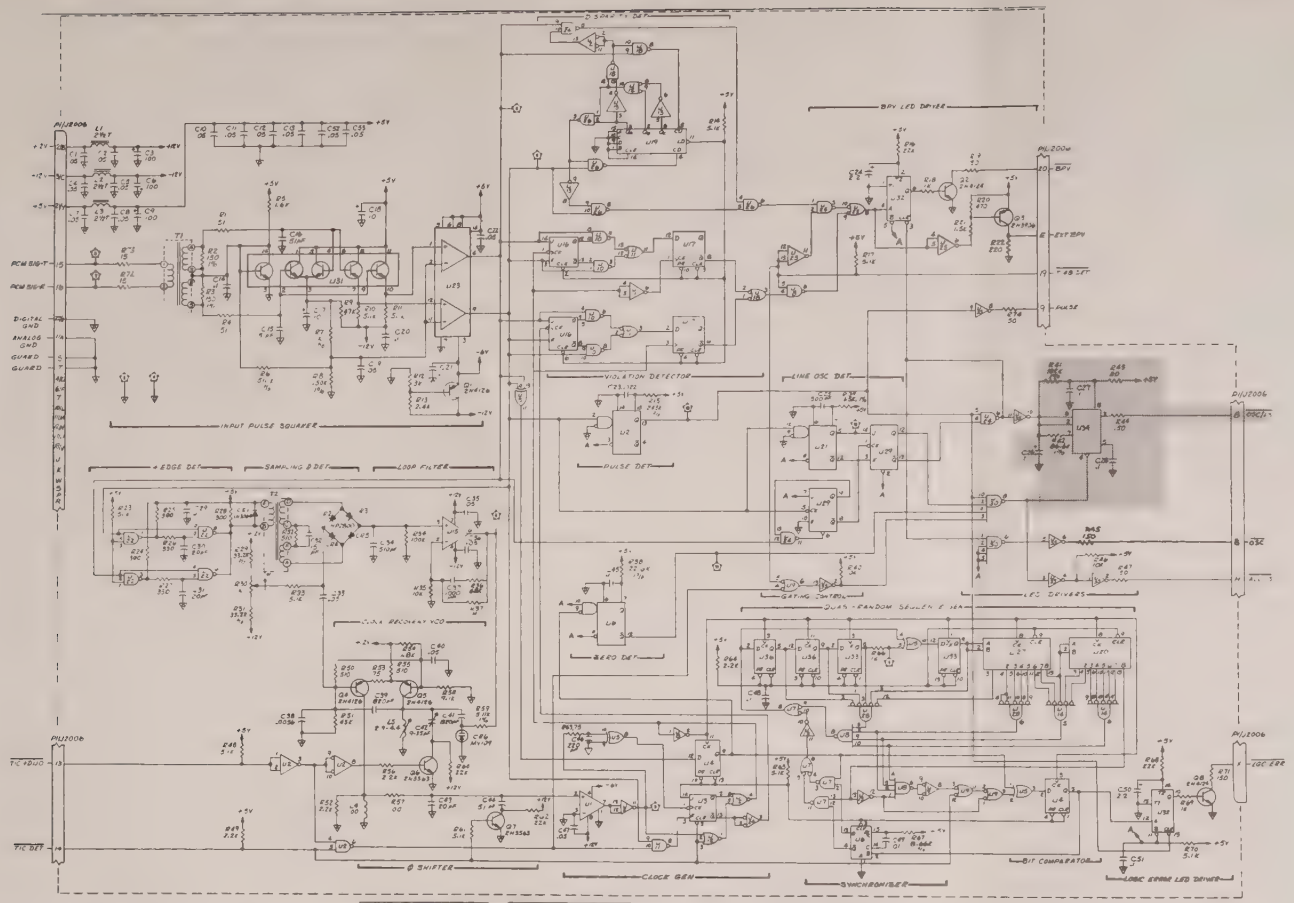


Figure 4-11. Error Detector Assembly. (CE-80B) 2400



NOTE:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Screened area used in some CE-80A units.

Figure 4-11. Error Detector (CE-80B), 2400

PATTERN GENERATOR/PULSE DRIVER. 2500

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2500	Pattern Generator/Pulse Driver	7001-0530	Cushman	
	PC Board Assy	1780-0901	Cushman	
	CAPACITORS			
C1	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C2	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C3	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C4	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C5	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C6	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C7	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C8	Mica, 100 pF, 5%, 500V	1002-0011	Elmenco	DM15-F-101J
C9	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C10	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C11	Cer, .1μF, 10%, 100V	1005-0064	Aerovox	CK06BX104K
C12	Mica, 100 pF, 5%, 500V	1002-0011	Elmenco	DM15-F-101J
C13	Mica, 30 pF, 5%, 500V	1002-0043	Elmenco	DM15-E-300J
C14	Mica, 100 pF, 5%, 500V	1002-0011	Elmenco	DM15-F-101J
C15	Cer, .1μF, 10%, 100V	1005-0064	Aerovox	CK06BX104K
C16	Mica, 30 pF, 5%, 500V	1002-0043	Elmenco	DM15-E-300J
C17	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C18	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C19	Mica, 30 pF, 5%, 500V	1002-0043	Elmenco	DM15-E-300J
C20	Cer, .05μF, +80-20%, 500V	1005-0052	Sprague	5HK-S50
C21	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C22	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C23	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C24	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
	DIODES			
CR1	Si, Sw, 75 PRV	1281-0112	TI	1N914B
	INDUCTORS			
L1	RF Choke, 56μH, 5%	1585-0042	Delevan	1537-64
	TRANSISTORS			
Q1	PNP, Si, Low Pwr/Sw	1272-0097	Fairchild	2N4258
Q2	PNP, Si, Low Pwr/Sw	1272-0037	Motorola	2N3906
Q3	PNP, Si, Low Pwr/Sw	1272-0037	Motorola	2N3906
Q4	PNP, Si, Low Pwr/Sw	1272-0037	Motorola	2N3906
Q5	PNP, Si, Low Pwr/Sw	1272-0097	Fairchild	2N4258
	RESISTORS			
R1	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R2	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R3	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R4	Not used			
R5	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035

PATTERN GENERATOR/PULSE DRIVER, 2500 (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R6	Comp, 2.2K, 5%, 1/4W	1066-2225	Allen Bradley	CB2225
R7	Pot, 2K, 10%, 3/4W, 15T, Cermet	1215-0015	Beckman	89WR2K
R8	MF, 6.19K, 1%, 100 PPM	1075-0109	Dale	MFF 1/8 T1
R9	Comp, 68 Ohm, 5%, 1/2W	1067-6805	Allen Bradley	CB6805
R10	Comp, 5.6 Ohm, 5%, 1/4W	1066-0003	Allen Bradley	CB56G5
R11	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R12	Comp, 1.8K, 5%, 1/4W	1066-1825	Allen Bradley	CB1825
R13	MF, 562 Ohm, 1%, 100 PPM	1075-0041	Dale	MFF 1/8 T1
R14	MF, 887 Ohm, 1%, 100 PPM	1075-0022	Dale	MFF 1/8 T1
R15	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R16	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R17	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R18	Comp, 1.8K, 5%, 1/4W	1066-1825	Allen Bradley	CB1825
R19	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R20	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R21	MF, 43.2 Ohm, 1%, 100 PPM	1075-0069	Dale	MFF 1/8 T1
R22	MF, 43.2 Ohm, 1%, 100 PPM	1075-0069	Dale	MFF 1/8 T1
R23	MF, 432 Ohm, 1%, 100 PPM	1075-0142	Dale	MFF 1/8 T1
R24	MF, 432 Ohm, 1%, 100 PPM	1075-0142	Dale	MFF 1/8 T1
	TRANSFORMERS			
T1	Xfmr, Pulse 1:1 CT 1 MH Shielded	1576-0012	Cushman	
	INTEGRATED CIRCUITS			
U1	TTl, NAND Gates	2025-0114	TI	SN74LS00N
U2	Quad, 2 Input, Pos NOR Gates	2025-0108	TI	SN74LS02N
U3	74LS86, Quad, 2 Input, EXCL-OR	2025-0219	National	DM74LS86N
U4	Dual, J-K Flip Flop	2025-0110	TI	SN74LS73N
U5	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U6	74LS193, UP/DN Counter	2025-0228	National	DM74LS193N
U7	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U8	74LS112, Dual J-K Flip Flop	2025-0221	National	DM74LS112N
U9	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U10	TTL, NAND Gates	2025-0114	TI	SN74LS00N
U11	Hex Invertor	2025-0084	TI	SN74LS04N
U12	Quad, 2 Input, Pos NOR Gates	2025-0108	TI	SN74LS02N
U13	Dual, J-K Flip Flop	2025-0110	TI	SN74LS73N
U14	Hex Invertor	2025-0084	TI	SN74LS04N
U15	723 Prec Voltage Reg	2025-0155	Fairchild	723DC
U16	74LS112 Dual, J-K Flip Flop	2025-0221	National	DM74LS112N
U17	SN74L73N	2025-0041	TI	SN74L74N
U18	Dual, J-K Flip Flop	2025-0110	TI	SN74LS73N
U19	74LS10, Triple, 3 Input NAND	2025-0215	National	DM74LS10N
U20	74LS95, 4-Bit Shift Rgstr	2025-0220	Fairchild	73LS95PC
U21	Dual, J-K Flip Flop	2025-0110	TI	SN74LS73N
U22	Dual, J-K Flip Flop	2025-0110	TI	SN74LS73N
U23	7416 Hex Inverter Driver W/Hv Out	2025-0119	TI	SN7416N
U24	74LS163, Synch, 4-Bit Cntr	2025-0223	National	DM74LS163N
U25	74LS20, Dual 4 Input NAND	2025-0216	National	DM74LS20N
U26	74S288, Prom Xmit Conv	2025-0231	Signetics	N82S123B
U27	74LS95, 4-Bit Shift Regstr	2025-0220	Fairchild	74LS95PC
U28	TTL, NAND Gates	2025-0114	TI	SN74LS00N

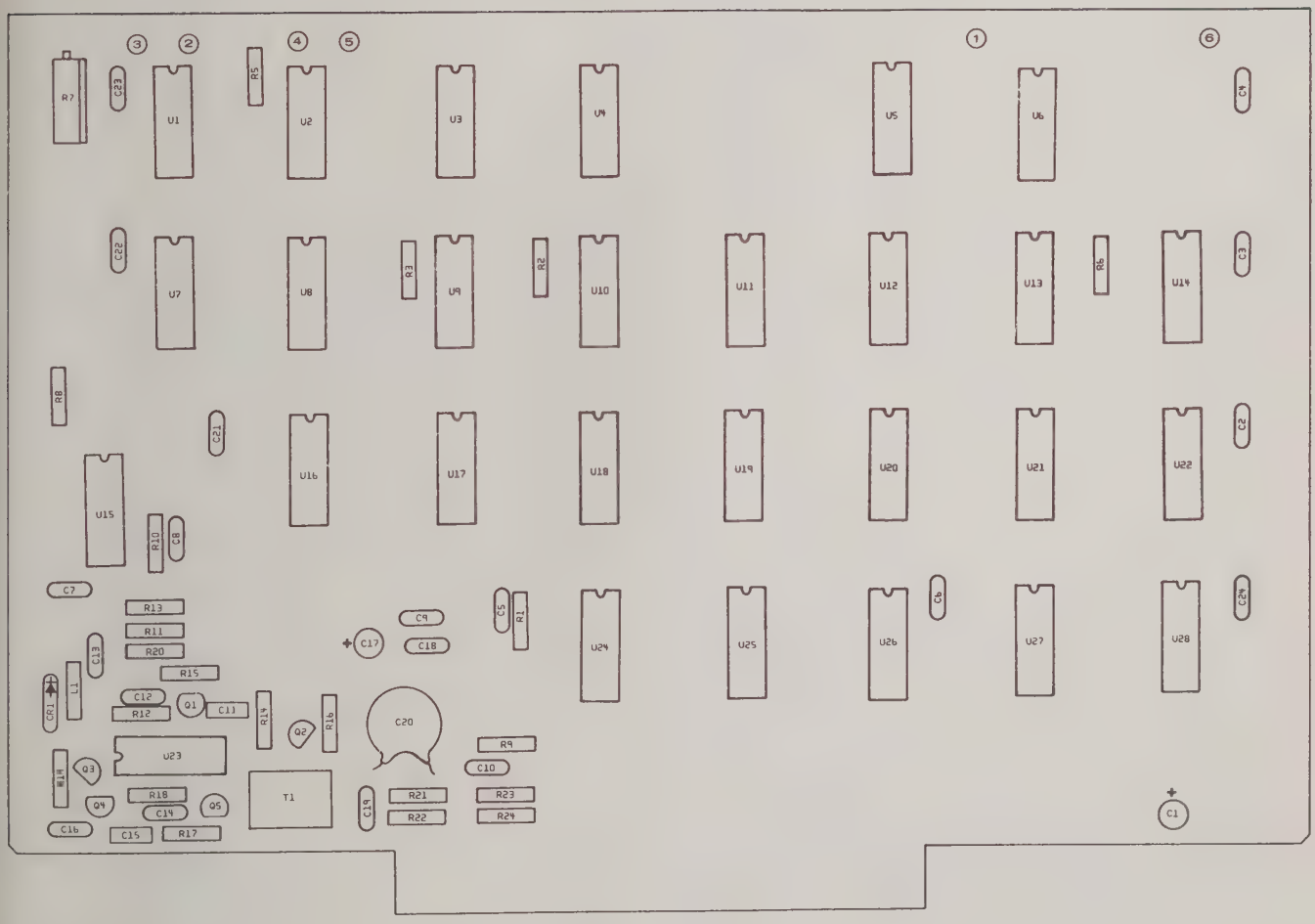
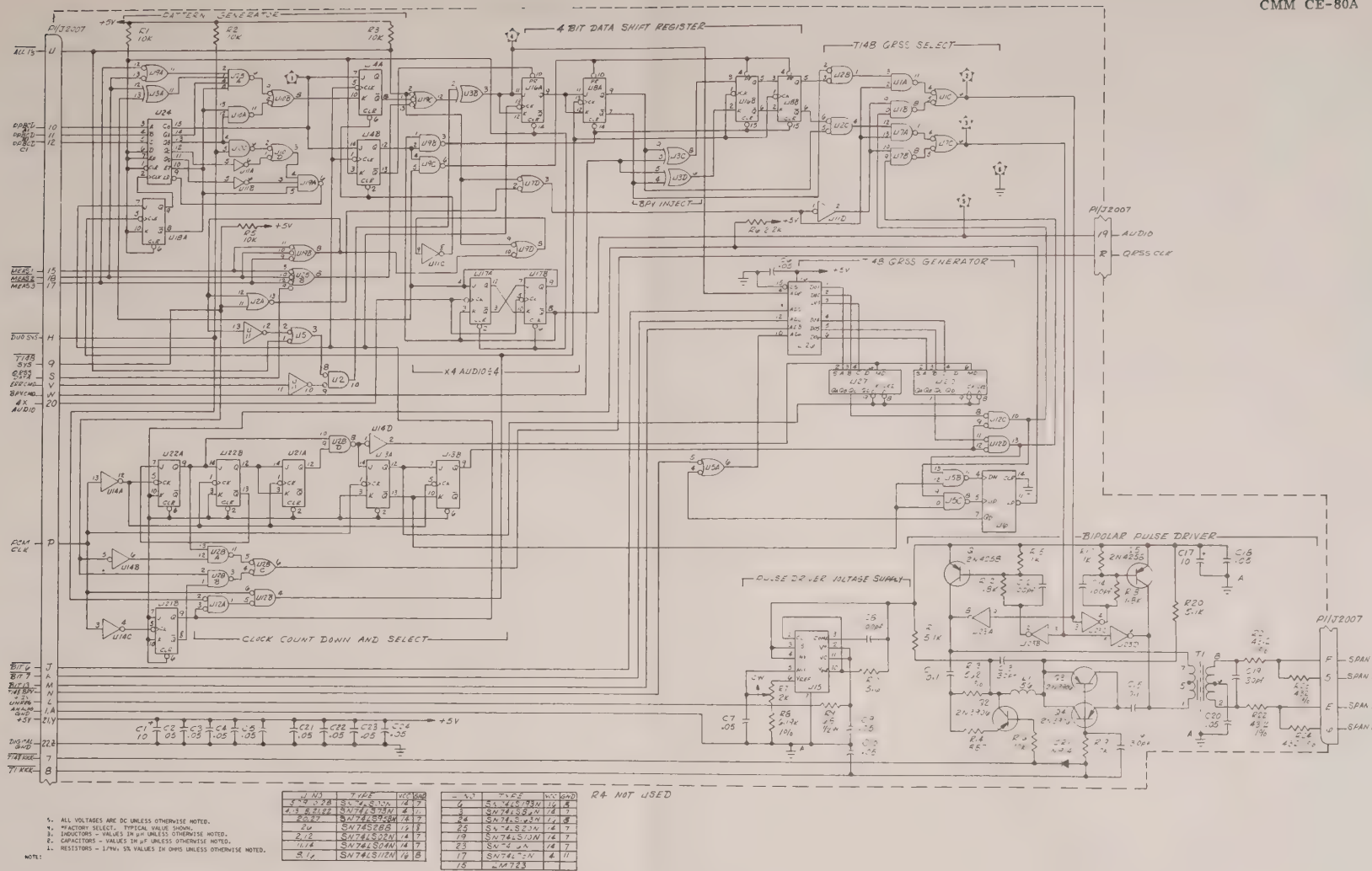


Figure 4-12. Pattern Generator/Pulse Driver. 2500



NOTE:
1. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
2. *FACTORY SELECT. TYPICAL VALUE SHOWN.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
5. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.

IC NO.	TYPE	VCC	GND
5,9,20,28	SN74S00N	14	7
4,6,21,22	SN74S74N	14	7
8,27	SN74LS75N	12	7
26	SN74S288	12	8
2,12	SN74LS02N	14	7
10,14	SN74LS04N	14	7
3,24	SN74LS10N	14	8

IC NO.	TYPE	VCC	GND
4	SN74LS73N	14	8
6	SN74LS32N	14	7
24	SN74LS08N	14	8
25	SN74LS20N	14	7
19	SN74LS10N	14	7
23	SN74 N	14	7
17	SN74L N	4	11
15	MM723		

Figure 4-12. Pattern Generator/Pulse Driver, 2500

CLOCK OSCILLATOR/QRSS. 2600 (CE-80A)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2600	Clock Oscillator/QRSS	7001-0529	Cushman	
	PC Board Assy	1780-0904	Cushman	
	CAPACITORS			
C1	Cer, .1μF, 10%, 100V	1005-0064	Aerovox	CK06BX104K
C2	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C3	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C4	Trmr, 5.5-60pF, 100V	1001-0022	Sprague	GXD60000
C5	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C6	Mica, 1000pF, ±5%, 500V	1002-0015	Elmenco	DM15-F-102J
C7	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C8	Trmr, 2-8pF, 350V, NPO	1001-0010	Erie	538-006A (2-8)
C9	Mica, 36pF, ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C10	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C11	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C12	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C13	Cer, .1μF, ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C14	Mica, 43pF, ±5%, 500V	1002-0046	Sangamo	D155E430
C15	Trmr, 5.5-60pF, 100V	1001-0022	Sprague	GXD60000
C16	Mica, 43pF, ±5%, 500V	1002-0046	Sangamo	D155E430
C17	Trmr, 5.5-60pF, 100V	1001-0022	Sprague	GXD60000
C18	Mica, 1000pF, ±5%, 500V	1002-0015	Elmenco	DM15-F-102J
C19	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C20	Mica, 820pF, ±5%, 300V	1002-0039	Elmenco	DM15-F-821J
C21	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C22	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C23	Trmr, 2-8pF, 350V, NPO	1001-0010	Erie	538-006A (2-8)
C24	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C25	Trmr, 2-8pF, 350V, NPO	1001-0010	Erie	538-006A (2-8)
C26	Tant, 10μF, +50-20%, 35V	1011-0006	Matsuo	DTS3502-106M
C27	Mica, 36pF, ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C28	Mica, 36pF, ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C29	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C30	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C31	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C32	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C33	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C34	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C35	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C36	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C37	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C38	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
	DIODES			
CR1	Si, Sw, 75PRV	1281-0112	TI	1N914B
CR2	Si, Sw, 75PRV	1281-0112	TI	1N914B
	INDUCTORS			
L1	RF Choke, 22μH, 10%	1585-0012	Delevan	1537-44
L2	RF Choke, 15μH, 10%	1585-0034	Delevan	1537-40
L3	RF Choke, 10μH, 10%	1585-0016	Delevan	1537-36

CLOCK OSCILLATOR/QRSS, 2600 (CE-80A) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	TRANSISTORS			
Q1	PNP, Si, Low Pwr	1272-0090	Fairchild	2N4126
Q2	PNP, Si, Low Pwr	1272-0090	Fairchild	2N4126
Q3	NPN, Si, Low Pwr/Sw	1272-0016	Fairchild	2N4275
Q4	PNP, Si, Low Pwr	1272-0090	Fairchild	2N4126
Q5	PNP, Si, Low Pwr	1272-0090	Fairchild	2N4126
Q6	PNP, Si, Low Pwr	1272-0090	Fairchild	2N4126
Q7	PNP, Si, Low Pwr	1272-0090	Fairchild	2N4126
	RESISTORS			
R1	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R2	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R3	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R4	MF, 2.21K, ±1%, 100PPM	1075-0010	Dale	MFF 1/8 T1
R5	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R6	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R7	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R8	Comp, 3.3K, ±5%, 1/4W	1066-3325	Allen Bradley	CB3325
R9	Comp, 47K, ±5%, 1/4W	1066-4735	Allen Bradley	CB4735
R10	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R11	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R12	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R13	MF, 2.21K, ±1%, 100PPM	1075-0010	Dale	MFF 1/8 T1
R14	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R15	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R16	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R17	Comp, 3.3K, ±5%, 1/4W	1066-3325	Allen Bradley	CB3325
R18	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R19	Comp, 47K, ±5%, 1/4W	1066-4735	Allen Bradley	CB4735
R20	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R21	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R22	MF, 2.21K, ±1%, 100PPM	1075-0010	Dale	MFF 1/8 T1
R23	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R24	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R25	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R26	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R27	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R28	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R29	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R30	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R31	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
	INTEGRATED CIRCUITS			
U1	IC, Hex Inverter	2025-0084	TI	SN74LS04N
U2	IC, Quad 2-input NOR gate	2025-0108	TI	SN74LS02N
U3	IC, Dual J-K Flip Flop	2025-0110	TI	SN74LS73N
U4	IC, Dual 4-input NAND gate	2025-0216	National	DM74LS20N
U5	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N

CLOCK OSCILLATOR/QRSS (CE-80A) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
U6	IC, Dual 4-input NAND gate	2025-0216	National	DM74LS20N
U7	IC, Quad 2-input NOR gate	2025-0108	TI	SN74LS02N
U8	IC, Dual J-K Flip Flop	2025-0110	TI	SN74LS73N
U9	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U10	IC, Triple 3-input NOR gate	2025-0217	National	DM74LS27N
U11	IC, Shift Register	2025-0224	National	DM74LS164N
U12	IC, Dual 5-input NOR gate	2025-0229	Signetics	N74LS260A
U13	IC, Up/Dn Counter	2025-0228	National	DM74LS193N
U14	IC, Shift Register	2025-0224	National	DM74LS164N
U15	IC, Quad 2-input Exclusive OR	2025-0219	National	DM74LS86N
U16	IC, Shift Register	2025-0224	National	DM74LS164N
U17	IC, Hex Inverter	2025-0084	TI	SN74LS04N
	CRYSTALS			
Y1	Xtal, 3.088 MHz	2035-0034	Cushman	
Y2	Xtal, 4.740 MHz	2035-0036	Cushman	
Y3	Xtal, 6.304 MHz	2035-0035	Cushman	

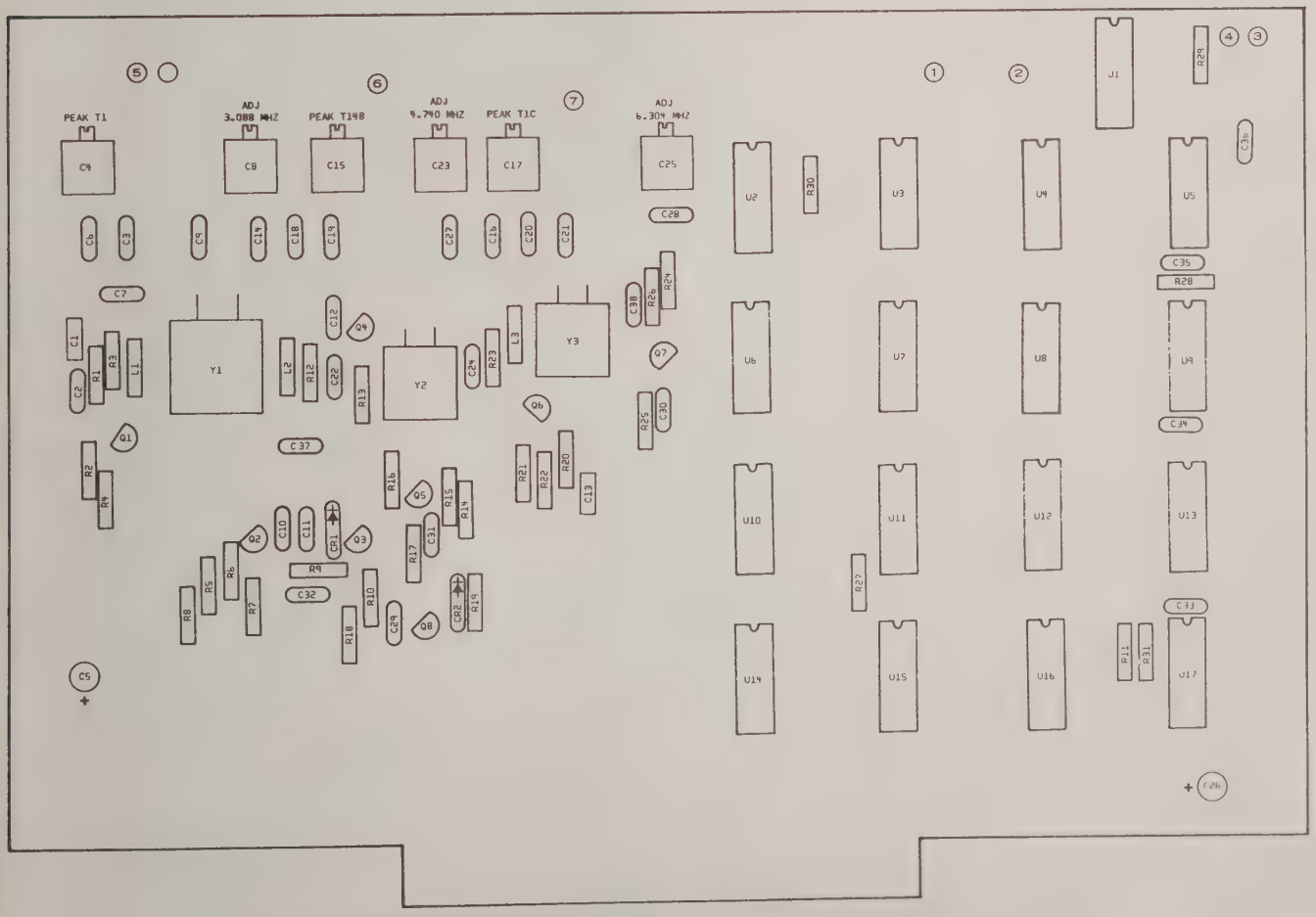
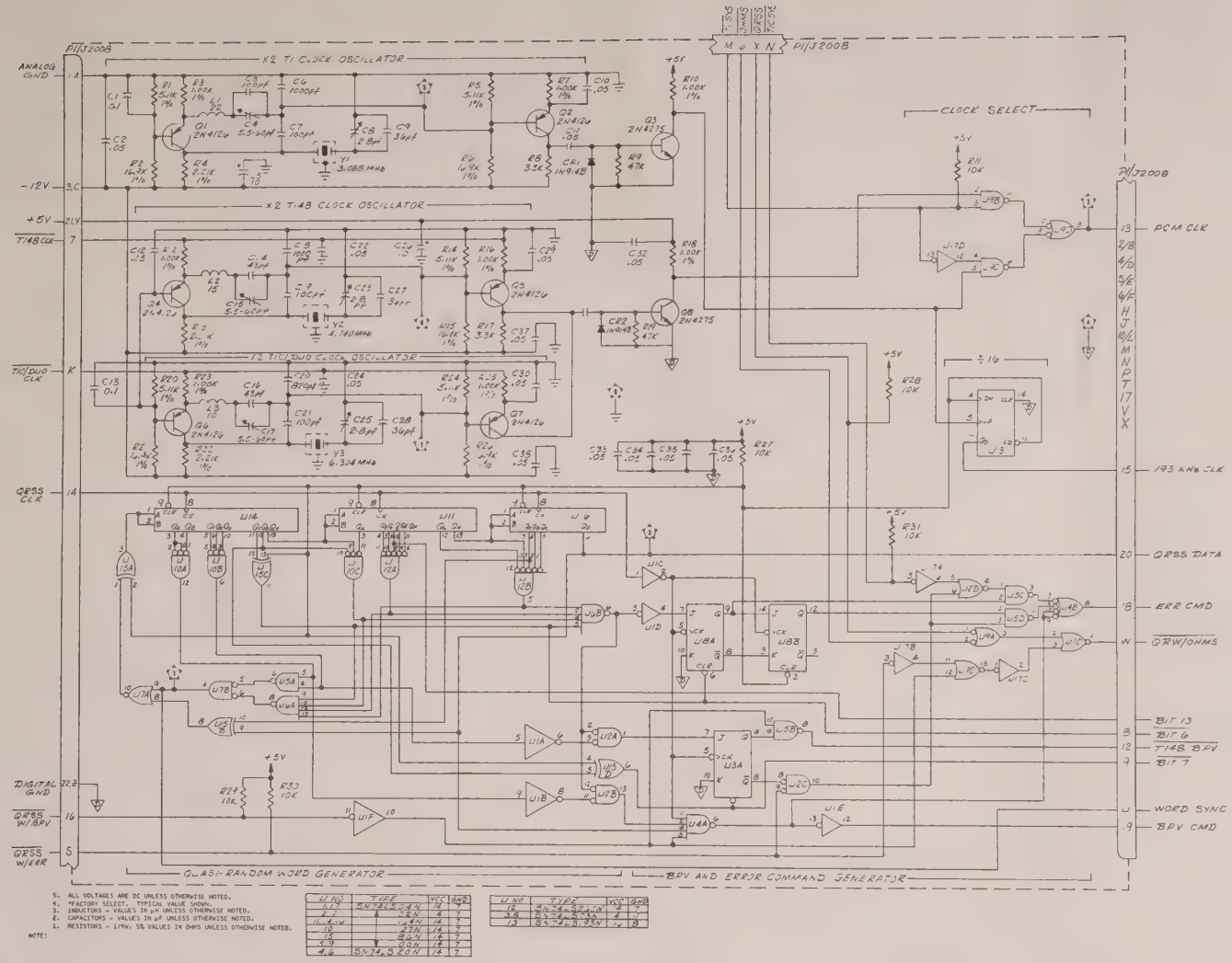


Figure 4-13. Clock Oscillator/QRSS. 2600 (CE-80A)



NOTE:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

U NO	TYPE	VCC	GND
1,7	SN74S20N	14	7
2,5	74N	14	7
11,4,14	74N	14	7
10	27N	14	7
12	86N	14	7
3,9	00N	14	7
4,6	SN74LS28N	14	7

U NO	TYPE	VCC	GND
12	SN74LS21N	14	7
3,6	SN74LS30N	4	11
13	SN74LS04N	14	8

Figure 4-13. Clock Oscillator/QRSS (CE-80A), 2600

CLOCK OSCILLATOR/QRSS. 2600 (CE-80B)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2600	Clock Oscillator/QRSS	7001-0520	Cushman	
	PC Board Assy	1780-0904	Cushman	
	CAPACITORS			
C1	Cer, .1μF, ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C2	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C3	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C4	Trmr, 5.5-60pF, 100V	1001-0022	Sprague	GXD60000
C5	Tant, 10μF, ±20%, 35V	1011-0006	Matsuo	221L3502106M3
C6	Mica, 1000pF, ±5%, 500V	1002-0015	Elmenco	DM15-F-102J
C7	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C8	Trmr, 2-8pF, 350V NPO	1001-0010	Erie	538-006A (2-8)
C9	Mica, 36pF, ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C10	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C11	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C12	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C13	Cer, .1μF, ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C14	Mica, 43pF, ±5%, 500V	1002-0046	Sangamo	D155E430
C15	Trmr, 5.5-60pF, 100V	1001-0022	Sprague	GXD60000
C16	Mica, 43pF, ±5%, 500V	1002-0046	Sangamo	D155E430
C17	Trmr, 5.5-60pF, 100V	1001-0022	Sprague	GXD60000
C18	Mica, 1000pF, ±5%, 500V	1002-0015	Elmenco	DM15-F-102J
C19	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C20	Mica, 820pF, ±5%, 300V	1002-0039	Elmenco	DM15-F-821J
C21	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C22	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C23	Trmr, 2-8pF, 350V NPO	1001-0010	Erie	538-006A (2-8)
C24	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C25	Trmr, 2-8pF, 350V NPO	1001-0010	Erie	538-006A (2-8)
C26	Tant, 10μF, ±20%, 35V	1011-0006	Matsuo	221L3502106M3
C27	Mica, 36pF, ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C28	Mica, 36pF, ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C29	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C30	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C31	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C32	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C33	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C34	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C35	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C36	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C37	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
C38	Cer disc, .05μF, +80-20%, 25V	1005-0014	Erie	5835-514-Y5U-503Z
	DIODES			
CR1	Dio, Si Sw, 75PRV	1281-0112	TI	1N914B
CR2	Dio, Si Sw, 75 PRV	1281-0112	TI	1N914B
	INDUCTORS			
L1	Choke, 22μH, ±10%, RF	1585-0012	Delevan	1537-44
L2	Choke, 15μH, ±10%, RF	1585-0034	Delevan	1537-40
L3	Choke, 10μH, ±10%, RF	1585-0016	Delevan	1537-36

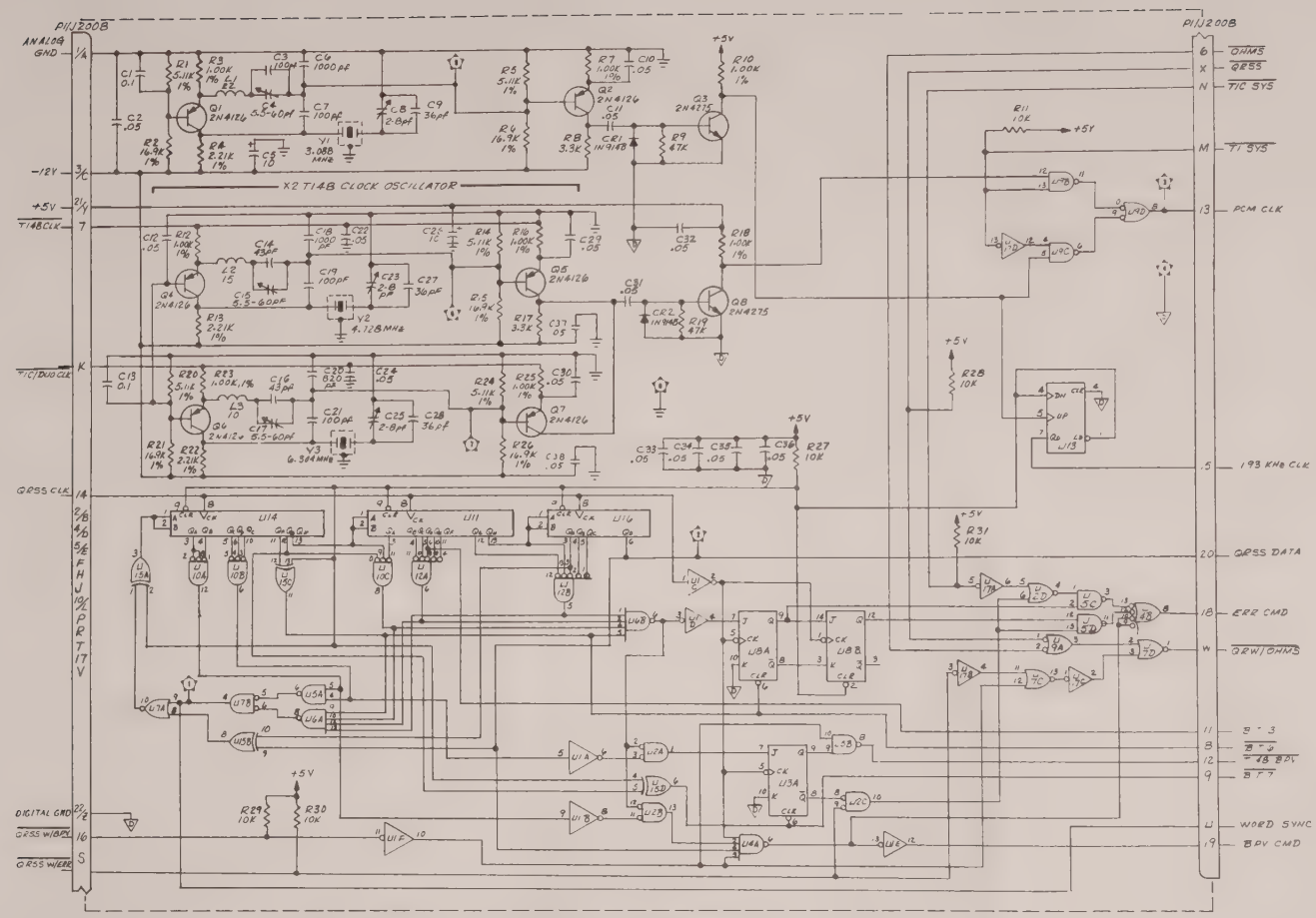
CLOCK OSCILLATOR/QRSS. 2600 (CE-80B) cont'd

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	TRANSISTORS			
Q1	PNP, Si Low Pwr	1272-0090	Fairchild	2N4126
Q2	PNP, Si Low Pwr	1272-0090	Fairchild	2N4126
Q3	NPN, Si Low Pwr/Sw	1272-0016	Fairchild	2N4275
Q4	PNP, Si Low Pwr	1272-0090	Fairchild	2N4126
Q5	PNP, Si Low Pwr	1272-0090	Fairchild	2N4126
Q6	PNP, Si Low Pwr	1272-0090	Fairchild	2N4126
Q7	PNP, Si Low Pwr	1272-0090	Fairchild	2N4126
Q8	NPN, Si Low Pwr/Sw	1272-0016	Fairchild	2N4275
	RESISTORS			
R1	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R2	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R3	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R4	MF, 2.21K, ±1%, 100PPM	1075-0010	Dale	MFF 1/8 T1
R5	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R6	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R7	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R8	Comp, 3.3K, ±5%, 1/4W	1066-3325	Allen Bradley	CB3325
R9	Comp, 47K, ±5%, 1/4W	1066-4735	Allen Bradley	CB4735
R10	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R11	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R12	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R13	MF, 2.21K, ±1%, 100PPM	1075-0010	Dale	MFF 1/8 T1
R14	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R15	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R16	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R17	Comp, 3.3K, ±5%, 1/4W	1066-3325	Allen Bradley	CB3325
R18	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R19	Comp, 47K, ±5%, 1/4W	1066-4735	Allen Bradley	CB4735
R20	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R21	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R22	MF, 2.21K, ±1%, 100PPM	1075-0010	Dale	MFF 1/8 T1
R23	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R24	MF, 5.11K, ±1%, 150PPM	1074-1018	Dale	MFF 1/8 T1
R25	MF, 1K, ±1%, 100PPM	1075-0037	Dale	MFF 1/8 T1
R26	MF, 16.9K, ±1%, 100PPM	1075-0059	Dale	MFF 1/8 T1
R27	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R28	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R29	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R30	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R31	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
	INTEGRATED CIRCUITS			
U1	IC, Hex Inverter	2025-0084	TI	SN74LS04N
U2	IC, Quad 2-input Pos NOR gate	2025-0108	TI	SN74LS02N
U3	IC, Dual J-K Flip Flop	2025-0110	TI	SN74LS73N
U4	IC, Dual 4-input NAND gate	2025-0216	National	DM74LS20N
U5	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N

CLOCK OSCILLATOR/QRSS. 2600. (CE-80B) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
U6	IC, Dual 4-input NAND gate	2025-0216	National	DM74LS20N
U7	IC, Quad 2-input Pos NOR gate	2025-0108	TI	SN74LS02N
U8	IC, Dual J-K Flip Flop	2025-0110	TI	SN74LS73N
U9	IC, Quad 2-input NAND gate	2025-0114	TI	SN74LS00N
U10	IC, Triple 3-input NOR gate	2025-0217	National	DM74LS27N
U11	IC, Shift Registers	2025-0224	National	DM74LS164N
U12	IC, Dual 5-input NOR	2025-0229	Signetics	N74LS260A
U13	IC, Up/Dn Counter	2025-0228	National	DM74LS193N
U14	IC, Shift Registers	2025-0224	National	DM74LS164N
U15	IC, Quad 2-input EXCL-OR	2025-0219	National	DM74LS86N
U16	IC, Shift Registers	2025-0224	National	DM74LS164N
U17	IC, Hex Inverter	2025-0084	TI	SN74LS04N
	CRYSTALS			
Y1	Xtal, 3.088 MHz	2035-0034	Cushman	
Y2	Xtal, 4.728 MHz	2035-0037	Cushman	
Y3	Xtal, 6.304 MHz	2035-0036	Cushman	

Figure 4-14. Clock Oscillator/QRSS Assembly. (CE-80B) 2600



NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

U NO.	TYPE	VCC	GND
1,17	SN74LS04N	14	7
2, 7	SN74LS02N	14	7
11,14,16	SN74LS14N	14	7
10	SN74LS32N	14	7
15	SN74LS86N	14	7
3, 9	SN74LS00N	14	7
4, 6	SN74LS20N	14	7

U NO.	TYPE	VCC	GND
12	SN74LS240N	14	7
3,8	SN74LS73N	4	11
13	SN74LS193N	16	8

Figure 4-14. Clock Oscillator/QRSS (CE-80B), 2600

POWER SUPPLY. 2700 (CE-80A)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2700	Power Supply	7001-0519	Cushman	
	PC Board	1780-0907	Cushman	
	CAPACITORS			
C1	Elect, 2200μF, +50-10%, 25V	1014-0021	United Chem	25TAL2200
C2	Elect, 1000μF, +50-10%, 25V	1014-0006	Illinois	25T1000
C3	Elect, 100μF, +75-10%, 25V	1013-0003	Sprague	30D107G025DD5
C4	Elect, 2200μF, +50-10%, 25V	1014-0021	United Chem	25TAL2200
C5	Elect, 1000μF, +50-10%, 25V	1014-0006	Illinois	25T1000
C6	Elect, 4700μF, +50-10%, 25V	1014-0017	Illinois	25T4700
C7	Elect, 2200μF, +50-10%, 25V	1014-0021	United Chem	25TAL2200
	DIODES			
CR1	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR2	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR3	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR4	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR5	Dio, Si Zener, 11V, 5%	1281-0107	Motorola	1N4741A
CR6	Dio, Si Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR7	Dio, Si Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR8	Dio, Si Zener, 3.6V, 5%	1281-0076	Fairchild	1N 747A
CR9	Dio, Si Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR10	Dio, Si Zener, 6.2V, 5%	1281-0104	Motorola	1N827
CR11	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR12	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR13	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR14	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR15	Dio, Si Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR16	Dio, Si Zener, 3.6V, 5%	1281-0076	Fairchild	1N747A
CR17	Dio, Si Rect, 400 PRV, 3A	1281-0111	Varo Semicon	V334
CR18	Dio, Si Rect, 400 PRV, 3A	1281-0111	Varo Semicon	V334
CR19	Dio, Si Zener, 3.6V, 5%,	1281-0076	Fairchild	1N747A
	TRANSISTORS			
Q1	Xstr, NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q2	Xstr, NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q3	Xstr, NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
	RESISTORS			
R1	Comp, 200 Ohm 5% 1/4W	1066-2015	Allen Bradley	CB2015
R2	Comp, 5.1K, 5% 1/4W	1066-5125	Allen Bradley	CB5125
R3	Comp, 4.3K, 5% 1/4W	1066-4325	Allen Bradley	CB4325
R4	Comp, 1K, 5% 1/4W	1066-1025	Allen Bradley	CB1025
R5	Comp, 510 Ohm, 5% 1/4W	1066-5115	Allen Bradley	CB5115
R6	Comp, 5.1K, 5% 1/4W	1066-5125	Allen Bradley	CB5125
R7	Comp, 820 Ohm, 5% 1/4W	1066-8215	Allen Bradley	CB8215
R8	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R9	Pot, 5K, 10% 3/4W, Cermet	1215-0012	Helitrim	89WR5K
R10	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1

POWER SUPPLY, 2700 (CE-80A) cont'd.

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R11	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R12	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R13	Comp, 510 Ohm, 5%, 1/4W	1066-5115	Allen Bradley	CB5115
R14	Comp, 5.1K, 5% 1/4W	1066-5125	Allen Bradley	CB5125
R15	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R16	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R17	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R18	Comp, 1K, 5%, 1/4W	1066-1025	Allen Bradley	CB1025
R19	Comp, 200 Ohm, 5%, 1/4W	1066-2015	Allen Bradley	CB2015
R20	Comp, 5.1K, 5%, 1/4W	1066-5125	Allen Bradley	CB5125
R21	MF, 6.98K, 1%, 150 PPM	1074-1028	Dale	MF 1/10 T9
R22	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R23	MF, 4.99K, 1%, 100 PPM	1075-0095	Dale	MFF 1/8 T1
R24	MF, 10K, 1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R25	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R26	Comp, 10K, 5%, 1/4W	1066-1035	Allen Bradley	CB1035
R27	MF, 5.11K, 1%, 150 PPM	1074-1018	Dale	MFF 1/8 T1
	INTEGRATED CIRCUITS			
U1	IC, General Purpose Op Amp	2025-0067	TI	UA741CP
U2	IC, General Purpose Op Amp	2025-0067	TI	UA741CP
U3	IC, General Purpose Op Amp	2025-0067	TI	UA741CP
U4	IC, 5V, 5%, Pos Rgltr	2025-0230	Motorola	MC78L05ACP
U5	IC, Quad Voltage Comptr	2025-0201	Motorola	MLM339P

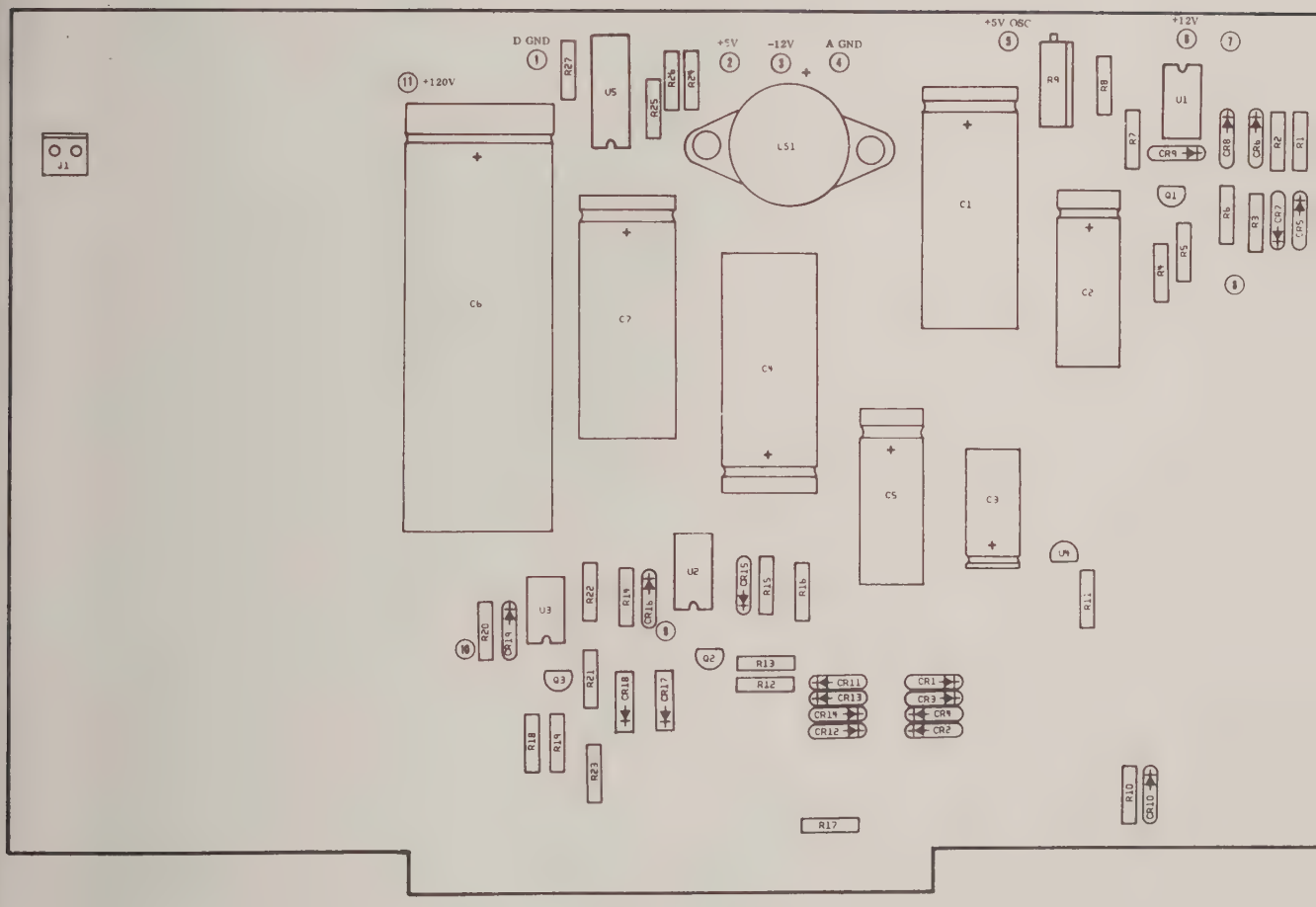
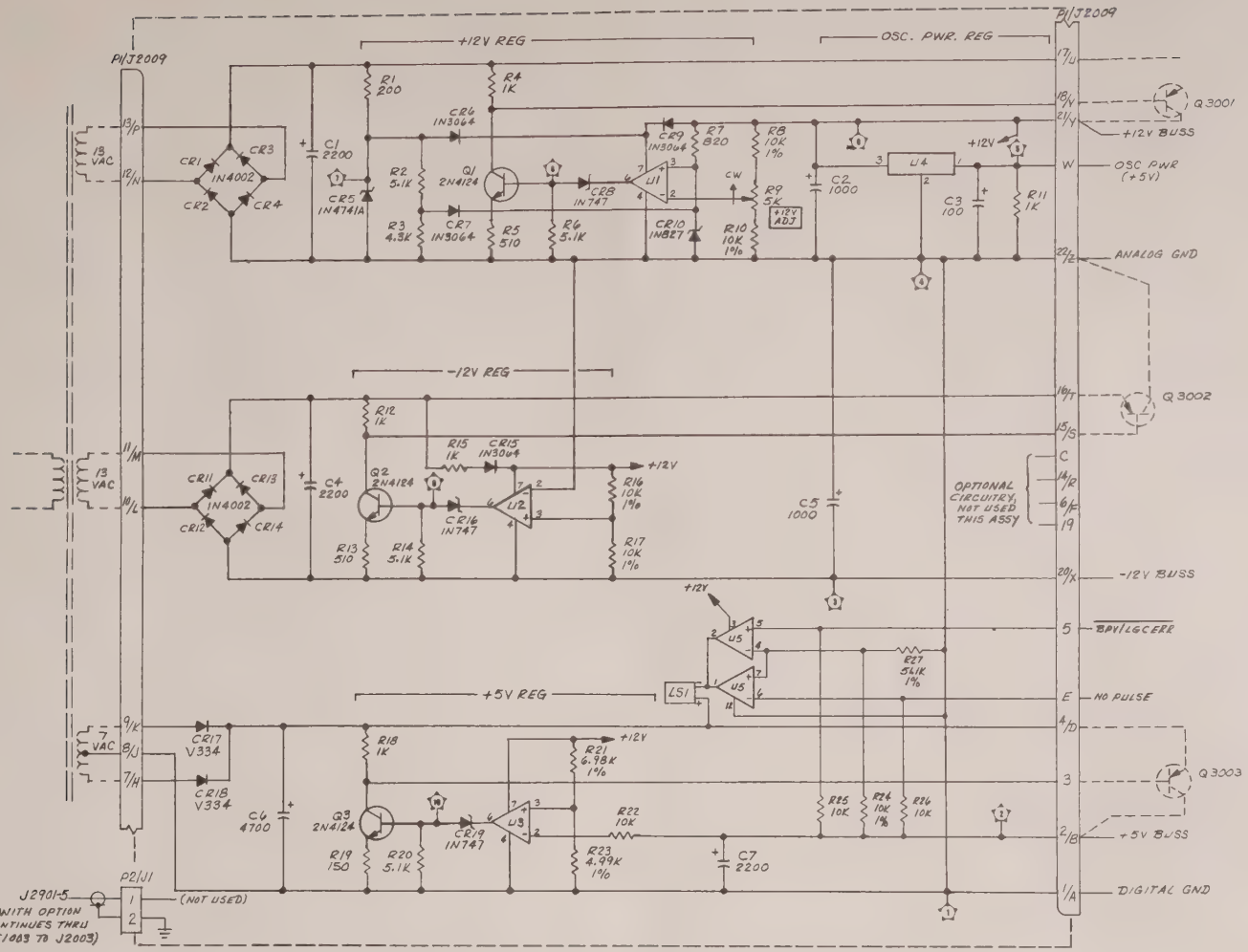


Figure 4-15. Power Supply Assembly (CE-80A; CE-80B Low Power). 2700.



U NO.	TYPE
1, 2, 3	741
4	78L05
5	LM339

NOTE:
1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 4-15. Power Supply. (CE-80A; CE-80B Low Power). 2700

POWER SUPPLY, 2700 (M3) CE-80B

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2700 (M3)	Power Supply	7001-0607	Cushman	
	PC Board	1780-0915	Cushman	
	CAPACITORS			
C1	Elect, 2200μF, +50-10%, 25V	1014-0021	United Chem	25TAL2200
C2	Elect, 1000μF, +50-10%, 25V	1014-0006	Illinois	25T1000
C3	Elect, 100μF, +75-10%, 25V	1013-0003	Sprague	30D107G025DD5
C4	Elect, 2200μF, +50-10%, 25V	1014-0021	United Chem	25TAL2200
C5	Elect, 1000μF, +50-10%, 25V	1014-0006	Illinois	25T1000
C6	Elect, 4700μF, +50-10%, 25V	1014-0017	Illinois	25T4700
C7	Elect, 2200μF, +50-10%, 25V	1014-0021	United Chem	25TAL2200
C8	Elect, 80μF, +100-10%, 200V	1014-0025	Cornell-Dub	WBR80-250
C9	Tant, 10μF, ±20%, 35V	1011-0006	Matsuo	221L3520106M3
C10	Cer, .01μF, ±10%, 200V	1005-0065	Aerovox	CK06BX103K
C11	Elect, 1μF, +75-10%, 450V	1014-0011	Illinois	450T1
C12	Cer, .1μF, ±20%, 50V	1005-0097	Erie	8121-050-651-104M
	DIODES			
CR1	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR2	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR3	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR4	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR5	Dio, Si Zener, 11V, 5%	1281-0107	Motorola	1N4741A
CR6	Dio, Si Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR7	Dio, Si Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR8	Dio, Si Zener, 3.6V, 5%	1281-0076	Fairchild	1N747A
CR9	Dio, Si Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR10	Dio, Si Zener, 6.2V, 5%	1281-0104	Motorola	1N827
CR11	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR12	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR13	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR14	Dio, Si Rect, 100 PRV	1281-0023	ITT	1N4002
CR15	Dio, Si Sw, 75 PRV	1281-0013	Fairchild	1N3064
CR16	Dio, Si Zener, 3.6V, 5%	1281-0076	Fairchild	1N747A
CR17	Dio, Si Rect, 400 PRV, 3A	1281-0111	Varo Semicon	V334
CR18	Dio, Si Rect, 400 PRV, 3A	1281-0111	Varo Semicon	V334
CR19	Dio, Si Zener, 3.6V, 5%	1281-0076	Fairchild	1N747A
CR20	Dio, Si Rect, 800 PRV	1281-0030	G.E.	1N5062
CR21	Dio, Si Zener, 6.9V, 20 PPM	1281-0151	National	LM329
CR22	Dio, Si Sw, 75 PRV	1281-0112	TI	1N914B
CR23	Dio, Si Sw, 75 PRV	1281-0112	TI	1N914B
CR24	Dio, Si Rect, 800 PRV	1281-0030	G.E.	1N5062
	FUSES			
F1	Fuse, 1/32A, 125V, Plug-in	1955-0022	Littelfuse	273.031
	SPEAKER			
LS1	Audio Indicator, 4 kHz, 12V nom.	1716-0001	Proj. Unlim.	A1-254
	RELAY			
K1	Relay, SPST, N.O., 5V DC	1313-0031	Elec-Trol	RA30451051

POWER SUPPLY, 2700 (M3) CE-80B (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	TRANSISTORS			
Q1	Xstr, NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q2	Xstr, NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q3	Xstr, NPN, Si, Low Pwr	1272-0091	Fairchild	2N4124
Q4	Xstr, PNP, Si, Low Pwr	1272-0088	Motorola	MPSA92
Q5	Xstr, PNP, Si, High Pwr	1272-0126	Motorola	MJE350
Q6	Xstr, NPN, Si, Low Pwr	1272-0031	Motorola	2N5089
Q7	Xstr, NPN, Si, Low Pwr	1272-0031	Motorola	2N5089
Q8	Xstr, NPN, Si, Low Pwr	1272-0089	Motorola	MPSA42
Q9	Xstr, NPN, Si, Low Pwr	1272-0031	Motorola	2N5089
Q10	Xstr, NPN, Si, Low Pwr	1272-0031	Motorola	2N5089
Q11	Xstr, NPN, Si, Low Pwr	1272-0089	Motorola	MPSA42
	RESISTORS			
R1	Comp, 200 Ohm, ±5%, 1/4W	1066-2015	Allen Bradley	CB2015
R2	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R3	Comp, 4.3K, ±5%, 1/4W	1066-4325	Allen Bradley	CB4325
R4	Comp, 1K, ±5%, 1/4W	1066-1025	Allen Bradley	CB1025
R5	Comp, 510 Ohm, ±5%, 1/4W	1066-5115	Allen Bradley	CB5115
R6	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R7	Comp, 820 Ohm, ±5%, 1/4W	1066-8215	Allen Bradley	CB8215
R8	MF, 10K, ±1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R9	Pot, 5K, ±10%, 3/4W, Cermet	1215-0012	Helitrim	89WR5K
R10	MF, 10K, ±1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R11	Comp, 1K, ±5%, 1/4W	1066-1025	Allen Bradley	CB1025
R12	Comp, 1K, ±5%, 1/4W	1066-1025	Allen Bradley	CB1025
R13	Comp, 510 Ohm, ±5%, 1/4W	1066-5115	Allen Bradley	CB5115
R14	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R15	Comp, 1K, ±5%, 1/4W	1066-1025	Allen Bradley	CB1025
R16	MF, 10K, ±1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R17	MF, 10K, ±1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R18	Comp, 1K, ±5%, 1/4W	1066-1025	Allen Bradley	CB1025
R19	Comp, 150 Ohm, ±5%, 1/4W	1066-1515	Allen Bradley	CB1515
R20	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R21	MF, 6.98K, ±1%, 150 PPM	1074-1028	Dale	MF 1/10 T9
R22	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R23	MF, 4.99K, ±1%, 100 PPM	1075 0095	Dale	MFF 1/8 T1
R24	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R25	MF, 10K, ±1%, 100 PPM	1075-0009	Dale	MFF 1/8 T1
R26	MF, 51.1K, ±1%, 100 PPM	1075-0099	Dale	MFF 1/8 T1
R27	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R28	Comp, 180K, ±5%, 1/4W	1066-1845	Allen Bradley	CB1845
R29	MF, 27.4K, ±1%, 150 PPM	1074-1012	Dale	MF
R30	Comp, 1K, ±5%, 1/4W	1066-1025	Allen Bradley	CB1025
R31	Comp, 1.5K, ±5%, 1/4W	1066-1525	Allen Bradley	CB1525
R32	MF, 137K, ±1%, 100 PPM	1075-0209	Dale	MFF 1/8 T1
R33	MF, 511K, ±1%, 100 PPM	1075-0156	Dale	MFF 1/8 T1
R34	MF, 24.3K, ±1%, 100 PPM	1075-0097	Dale	MFF 1/8 T1
R35	MF, 51.1K, ±1%, 100 PPM	1075-0099	Dale	MFF 1/8 T1

POWER SUPPLY, 2700 (M3) CE-80B (cont'd)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R36	MF, 20K, ±1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R37	MF, 20K, ±1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R38	Comp, 10K, ±5%, 1/4W	1066-1035	Allen Bradley	CB1035
R39	Comp, 240K, ±5%, 1/4W	1066-2445	Allen Bradley	CB2445
R40	MF, 4.32K, ±1%, 100 PPM	1075-0111	Dale	MFF 1/8 T1
R41	Comp, 39 Ohm, ±5%, 1/4W	1066-3905	Allen Bradley	CB3905
R42	MF, 511K, ±1%, 100 PPM	1075-0156	Dale	MFF 1/8 T1
R43	Pot, 5K, ±10%, 3/4W, Cermet	1215-0012	Helitrim	89WR5K
R44	MF, 20K, ±1%, 100 PPM	1075-0096	Dale	MFF 1/8 T1
R45	MF, 40.2 Ohm, 100 PPM	1075-0124	Dale	MFF 1/8 T1
R46	MF, 2.43K, ±1%, 100 PPM	1075-0019	Dale	MFF 1/8 T1
R47	MF, 301 Ohm, ±1%, 100 PPM	1075-0048	Dale	MFF 1/8 T1
R48	MF, 200K, ±1%, 100 PPM	1075-0148	Dale	MFF 1/8 T1
R49	MF, 18.7K, ±1%, 150 PPM	1074-1022	Dale	MF 1/10 T9
R50	MF, 1.07K, ±1%, 100 PPM	1075-0166	Dale	MFF 1/8 T1
R51	Comp, 51 Ohm, ±5%, 1/4W	1066-5105	Allen Bradley	CB5105
R52	Comp, 12K, ±5%, 1/4W	1066-1235	Allen Bradley	CB1235
R53	Comp, 5.1K, ±5%, 1/4W	1066-5125	Allen Bradley	CB5125
R54	Comp, 10 Ohm, ±5%, 1/4W	1066-1005	Allen Bradley	CB1005
	INTEGRATED CIRCUITS			
U1	IC, General Purpose Op Amp	2025-0067	TI	UA741CP
U2	IC, General Purpose Op Amp	2025-0067	TI	UA741CP
U3	IC, General Purpose Op Amp	2025-0067	TI	UA741CP
U4	IC, 5V, ±5%, Pos Rgltr	2025-0230	Motorola	MC78L05ACP
U5	IC, Quad Voltage Comptr	2025-0201	Motorola	MLM339P
U6	IC, Op Amp	2025-0266	Intersil	ICL7621DCPA
U7	IC, Optocoupler, High Gain	2025-0265	HP	4N46
	DIODE BRIDGE			
Z1	Brdg, Si Rect Diode, 400 PRV	1281-0103	Varo	VM48

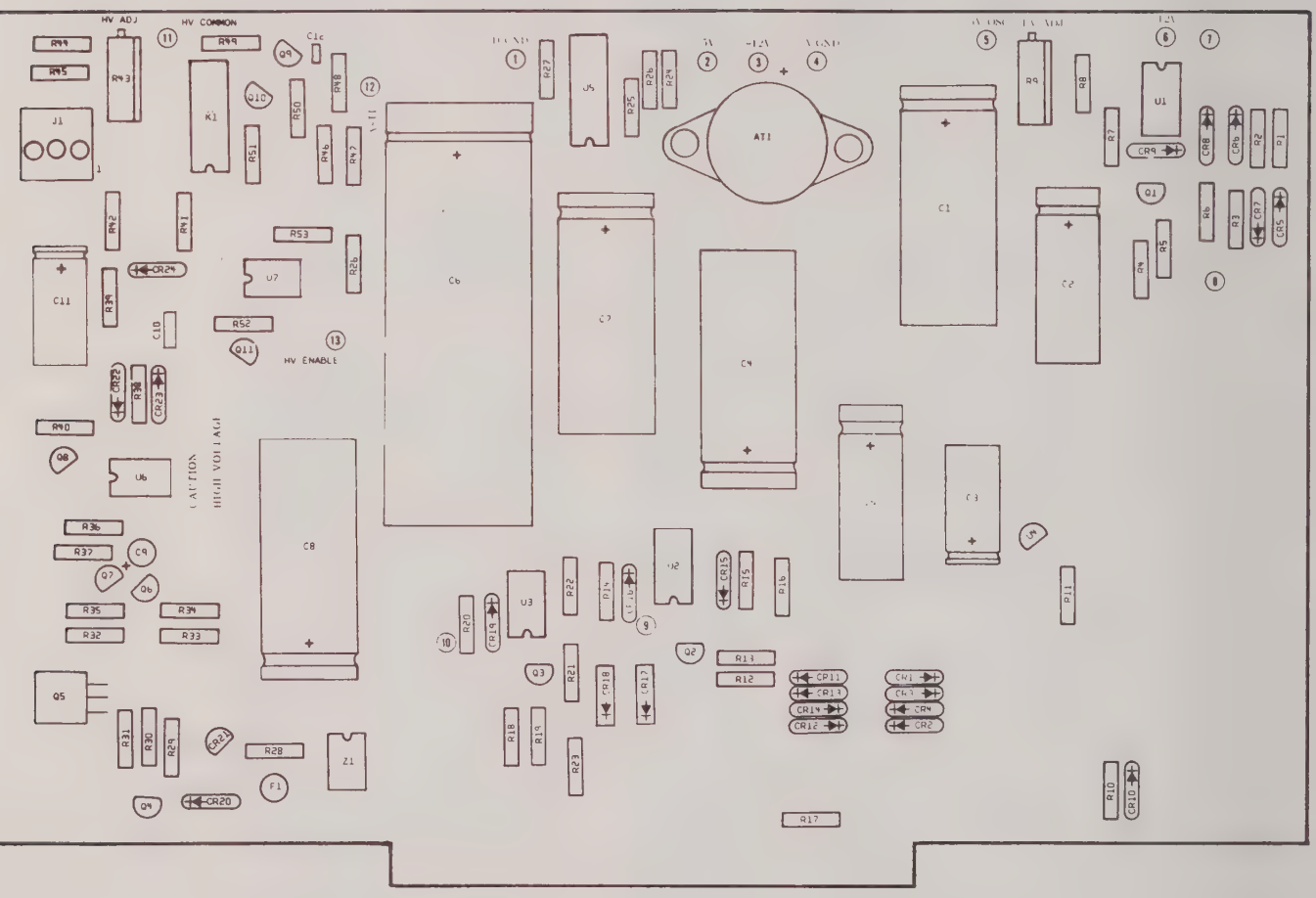
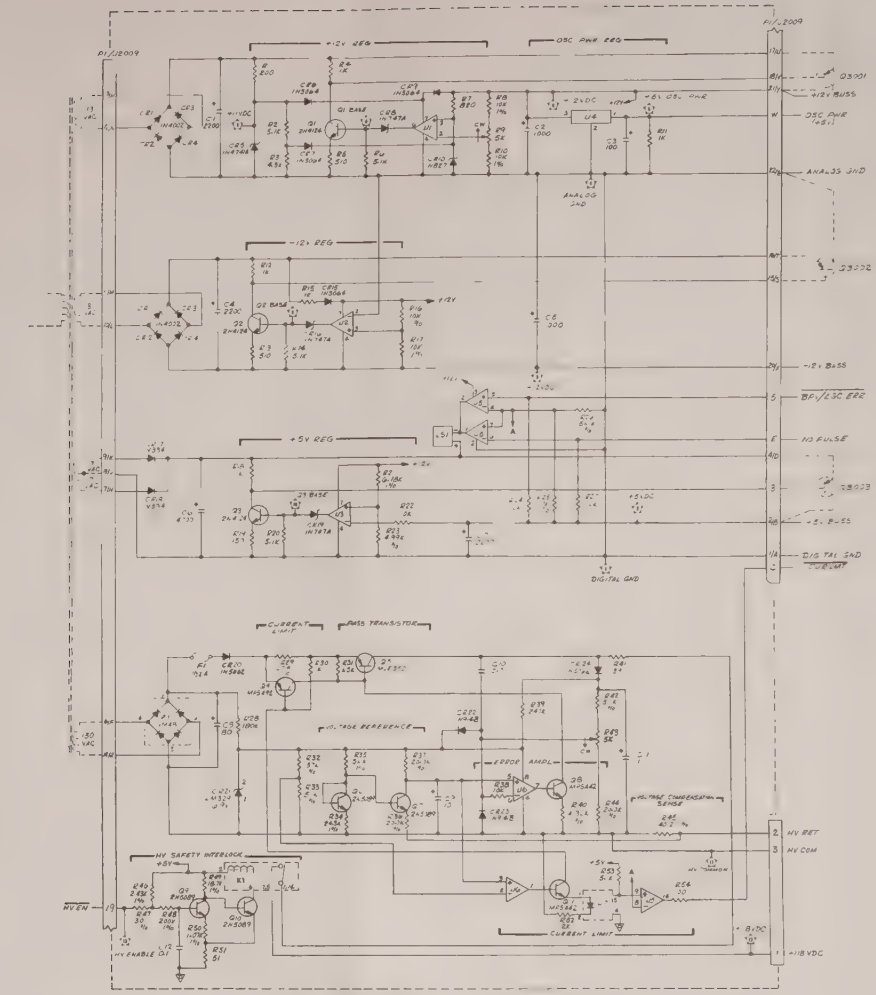


Figure 4-16. Power Supply Assembly. (CE-80B, M3 Low and High Voltage), 2700



NOTE
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

ITEM	TYPE	MFG CODE
CR 3	1N4744A	4
4	1N4733A	—
5	LM339	34 2
6	2N5401	28 2
7	2N4400	4 —

Figure 4-16. Power Supply (CE-80B, M3 Low and High Voltage), 2700

Panel, Rear. 3000

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3000	Panel, Rear	2800-0256	Cushman	
	FUSES			
F1	Fuse, 3/8 Amp, 3 AG Slo-Blo	1955-0038	Littelfuse	313.375/S
	Fuseholder, Blk	1965-0001	Littelfuse	342012AL
	CONNECTORS			
J1	Conn, BNC Jk Rect Panel Mt	2536-0010	Kings	KC79-35
J2	Conn, 3 pin Mini Rect Housing	2535-0035	Molex	03-06-1032
	TRANSISTORS			
Q1	PNP, Si High Pwr/Sw	1272-0118	Texas Inst	TIP-32
Q2	PNP, Si High Pwr/Sw	1272-0118	Texas Inst	TIP-32
Q3	PNP, Si High Pwr/Sw	1272-0118	Texas Inst	TIP-32
	POWER CORD			
	Cord, Power, 8 ft. single-ended	3170-0012	Cushman	

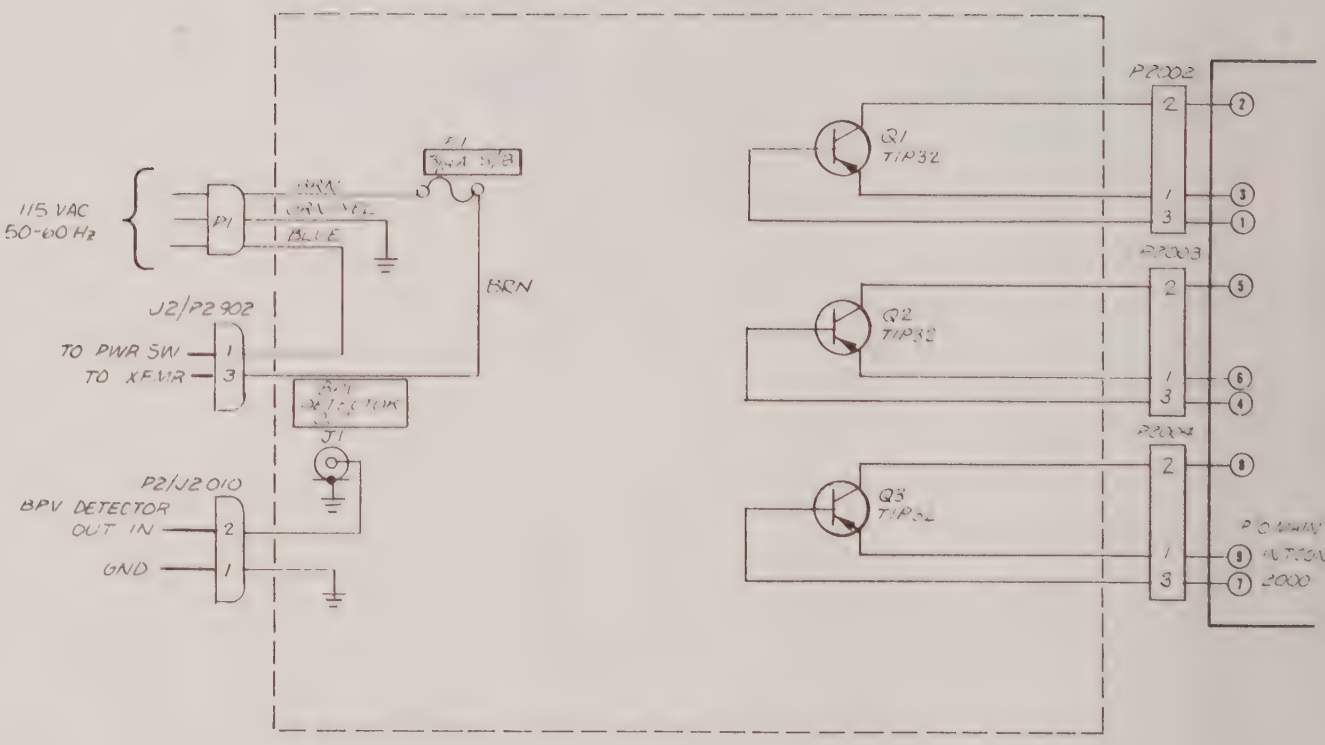


Figure 4-17. Rear Panel, 3000

Cushman Electronics, Inc.

1525 Atteberry Lane
San Jose, California 95131
(408) 263-8100 • TWX 910-338-0556

ACCOPRESS®

25970	YELLOW
25971	BLACK
25972	LIGHT BLUE
25973	DARK BLUE
25974	LIGHT GRAY
25975	LIGHT GREEN
25976	DARK GREEN
25977	TANGERINE
25978	RED
25979	EXECUTIVE RED

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